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[JULY, 1887.]

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OF THE
Mineralogical Society.

INSTITUTED 3rd FEBRUARY, 1876.

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THE MINERALOGICAL SOCIETY

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EXCERPT MINUTES OF COUNCIL MEETING

Held at the Museum, Jermyn Street, Jan. 11th, 1887.

The following gentlemen were elected—

A. PRINGLE, M.A.

G. T. PRIOR, B.A.

J. M. THOMSON, F.C.S.

Reported the death of Dr. E. H. FURUHJELM, of Helsingfors.

EXCERPT MINUTES OF COUNCIL MEETING

Held at 116 Victoria Street, April 4th, 1887.

The following gentlemen were elected—

F. W. PEARD, of Natal.

Prof. A. H. CHESTER, Hamilton Col. Clinton.

The audited Balance-Sheet for the year 1886 was submitted and ordered to be printed (p. xiv.).

GENERAL MEETING.

Held at the Museum, Jermyn Street, Jan. 11th, 1887.

L. FLETCHER, M.A., F.G.S., President, in the Chair.

The following papers were read:—

“On a Specimen of Meteoric Iron found at Youndegin, West Australia, 1884.” By L. Fletcher, M.A., President. (p. 121.)

“Additional Notes on the Felspar from Kilima-njaro.” By L. Fletcher, M.A., and H. A. Miers, M.A. (p. 131.)

Professor Bonney said that it was very satisfactory to find that a small collection of rock fragments made by a traveller, who did not profess to be a geologist, had contained specimens of such interest. The rocks which he had examined from Kilima-njaro¹ did not, as far as he could ascertain with the microscope, contain any nepheline, though of course it would not be safe to draw a general inference from that, seeing that the collection was a small one, and Kilima-njaro a very large mountain. The rocks which he had examined were varieties of augite-andesite, most of them very vitreous,—dark brown glasses,—probably belonging to the more basic side of that group of rocks. These felspar crystals occur in a mass of browned glass, containing minute microliths of felspar, with

¹ Described in *Report of Brit. Assoc. for 1885* (Aberdeen), p. 682.

occasional small vesicles; their exterior is somewhat corroded by the glass which is occasionally present as inclusions. Mr. Johnston had collected the specimens on the central ridge of Kilima-njaro (at 14,000 ft.), on Kimawenzi (15,000 ft.), and at the base of Kibo (14,000 ft.). The only non-volcanic specimen in the collection was a bit of a quartz crystal collected in a stream valley on the mountain at about 8,000 feet.

Professor Judd stated that he had seen the same structure as that described by Mr. Miers, as occurring in the Kilima-njaro felspar, in a very fresh example of the felspar in the Norwegian "Rhomben-porphyr." It did not appear to be a *true* "microcline" structure, though it showed some peculiar analogies with it.

"On the Occurrence of Greenockite in a New Locality." By Prof. M. F. Heddle, F.R.S.E. (p. 133.)

"Note on a Form of Calcite from Heilim, in Sutherland." By Prof. M. F. Heddle, F.R.S.E. (p. 138.)

"Note on the Occurrence of Bismutite in the Transvaal." By H. Louis, F.I.C. (p. 139.)

"Note on Celestine Crystals from Gloucestershire." By R. H. Solly, F.G.S. (p. 142.)

"Note on Apatite Crystals from Cornwall." By R. H. Solly, F.G.S. (p. 141.)

"Note on the presence of Lead in Calcite from the Leadhills District." By J. Stuart Thomson. (p. 143.)

"On the Use of the Gnomonic Projection." By H. A. Miers, M.A. (p. 145.)

Professor Judd exhibited a specimen of the new mineral "Awalruite," discovered by Prof. Ulrichs, which was a terrestrial alloy of Nickel and Iron (Ni_2Fe), being Nickel 67.63 per cent., and Iron 31.02 per cent. and which proved to be identical with the Octibbeha meteorite. Prof. Bonney remarked that the mineral occurred in an olivine sand, derived no doubt from peridotite rocks.

Colonel McMahon exhibited a sapphire from the Himalayas, which he thought some of the members might like to see, as it was of well-defined crystalline form, and showed well the characteristic habit of the Himalayan mineral. He regretted that he could not give the member

much information about the Himalayan sapphires. They came from the south-east portion of the territories of the Maharaja of Kashmir, called Padar, or Padam, on the borders of Zaskar—a particularly inaccessible corner of the Himalayas. As far as he could learn, a landslip revealed a vein of blue and white corundum in crystalline rocks in the year 1880-81. At first no importance was attached to the find, as the villagers thought the mineral was quartz, and valueless. Colonel McMahon was within about 30 miles of the place in September 1881, but heard nothing of the find at the time. As soon as the value of the mineral became known the Maharaja of Kashmir sent troops to the spot; caused the bridges leading into the valley to be broken down; and put a stop to any English or native traveller visiting it. Hence no geologist had been able to inspect the locality. He believed that the vein had since been worked out; but he saw no reason why similar sapphire veins should not be discovered hereafter in adjoining parts of the Himalayas.

GENERAL MEETING.

Held at the Museum, Jermyn Street, May 10th, 1887.

L. FLETCHER, M.A., President, in the Chair.

The following papers were read :—

“Microscopical Studies on some Eruptive Rocks from the Caucasus and Armenia.” By Dr. Hjalmar Gylling. (p. 155.)

“Note on some Specimens of Glaucophane Rock from the Ile de Noix.” By Rev. Prof. T. G. Bonney, LL.D. (p. 150.)

“Note on Francolite.” By F. H. Butler, M.A. (p. 164.)

“On the Crystalline Form of Kreatine.”¹ By the President.

“On a Granite containing Andalusite, from the Cheesewring, Cornwall.” By J. J. H. Teall, M.A., F.G.S. (p. 161.)

“On the Meteoric Iron seen to fall in the District of Nejed, in Central Arabia, in the Spring of 1865.”¹ By L. Fletcher, M.A., President.

Prof. Judd exhibited some specimens and sections of Tabasheer, and other forms of Opal.

¹ Will appear in the next Number.

Mineralogical Society—Abstract of Receipts and Payments from 1st January to 31st December, 1886.

RECEIPTS.		PAYMENTS.	
	£ s. d.		£ s. d.
Balance from year 1885	15 1 0	Printing	72 9 9
Subscriptions for current year	79 14 0	Illustrations	16 19 0
" Arrears	4 4 0	Expenses of Meetings	5 13 6
Entrance Fees and Life Composition	17 16 6	Editorial and Clerical Expenses	12 12 0
Sale of Publications	17 15 6	Postages, Parcels, &c.	8 17 0
Dividends on Stock	5 16 1	Investments	12 16 1
Prof. Bonney:—Payment on Plate I, Vol. VII.	3 3 0	Advertisements	0 14 6
R. H. Solly:—Extra Copies	1 13 6	Charge for keeping Stock of Publications and Insurance	5 9 0
Dr. Hedde:—Payment of charge on Cheque	0 0 6	Stand for Box containing Records	0 16 9
		Balance	8 16 6
	£145 4 1		£145 4 1

Examined and compared with the vouchers and found correct.

(Signed)

BENEDICT KITTO, }
F. W. RUDLER, } AUDITORS.

LIABILITIES.		ASSETS.	
	£ s. d.		£ s. d.
Editorial Expenses, 1886	10 10 0	Subscriptions for 1886 unpaid	29 2 0
Clerical	6 6 0	" 1885	14 14 0
Williams & Strahan, Printing, &c.	15 13 0	" 1884	5 5 0
S. Miller—Illustrations	1 15 0	"	2 2 0
Advertisements	0 5 0	Entrance Fees unpaid	206 19 4
Museum of Practical Geology, Gas, &c.	0 13 6	New 3 Per Cents. £204 8s. 3d. at 10½	20 1 5
Excess of Assets over Liabilities	265 5 6	Stock of Publications (average yearly sale)	12 17 8
		Simplin & Co., Sale of Publications	0 10 0
		Sale of Publications by Office—unpaid	8 16 6
		Cash in hand and at the Bank	£300 7 11
	£300 7 11		

Examined and compared with the vouchers and found correct.

(Signed)

ROBERT H. SCOTT,
General Secretary.

MINERALOGICAL SOCIETY..

DONATIONS FROM JULY 1ST TO DEC. 31ST, 1886.

The Fifth Annual Report of the United States Geological Survey, by J. W. Powell; Bulletin of the U. S. Geological Survey, Nos. 24 to 29; and Monograph on the Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. By Robert P. Whitfield.

Presented by the United States Geological Survey.

Proceedings of the Academy of Natural Sciences of Philadelphia. Part I., Jan. to March 1886.

Presented by the Academy.

The American Journal of Science; current numbers.

Presented by the Editors.

The American Chemical Journal for August and October.

Presented by the Editor.

Notes on the Peridotite of Elliot Co., Kentucky, by J. S. Diller; and on Turquoise from New Mexico, by F. W. Clarke and J. S. Diller.

Presented by J. S. Diller, Esq.

On the Brookite from Magnet Cove, Arkansas, by Edward S. Dana; and on two hitherto undescribed Meteoric Stones, by E. S. Dana and S. L. Penfield.

Presented by Professor E. S. Dana.

Observations on Volcanic Eruptions and Earthquakes in Iceland within historic times. By George H. Boehmer.

Presented by the Author.

Descriptive Catalogue of a Collection of the Economic Minerals of Canada. By the Geological Corps; A. R. C. Selwyn, Director.

Presented by the Geological Survey of Canada.

Catalogue of Geological Exhibits in the New Zealand Court, Colonial and Indian Exhibition. By Dr. James Hector, C.M.G., F.R.S.

Presented by the Geological Survey of New Zealand.

Report of the Mining Registrars of Victoria for the quarter ending 31st March, 1886.

Presented by R. T. Litton, Esq.

Report of Committee of Management of the Technological, Industrial and Sanitary Museum of New South Wales for 1885.

Presented by the Committee.

President's Address to the Royal Society of New South Wales. By Professor A. Liversidge, F.R.S.

Presented by the Author.

Transactions of the North of England Institute of Mining and Mechanical Engineers. Vol. XXXV. Parts 3 and 4.

Presented by the Institute.

Proceedings of the Bristol Naturalists' Society. New Series, Vol. V. Part I.

Presented by the Society.

The Naturalist: current numbers.

Presented by the Editor.

The Moloch of Paraffin. By Charles Marvin.

Presented by the Author.

Annalen des k.-k. naturhistorischen Hofmuseums, Wien. Redigirt von Dr. Franz Ritter von Hauer. Band I. Nos. 3 and 4.

Presented by the Editor.

Jahrbuch der k.-k. geologischen Reichsanstalt, Wien: Band XXXVI. Heft 2 and 3. Verhandlungen, Nos. 8 to 14. 1886.

Presented by the Institute.

Mineralogische und petrographische Mittheilungen: von G. Tschermak. N. F., Bd. VII. Heft VI.; Bd. VIII. Heft. I. and II.

Presented by the Editor.

Zeitschrift für Naturwissenschaften, Folge IV., Bd. V. Hefte 1-6.

Presented by the Editors.

- Vorträge und Mittheilungen. Von G. vom Rath. Presented by the Author.
 Mineralogische Notizen. 1886. Von G. vom Rath. Presented by the Author.
 Worte der Erinnerung an Prof. Dr. A. von Lasaulx. Von G. vom Rath.
 Presented by the Author.
 Seccion de Minas del Departamento de Obras públicas de la República Argentina.
 Primer Año, 1885. Presented by L. Albertini.
 Beobachtungen an Stassfurter Vorkommnissen; von Dr. O. Leudecke. Ueber ein
 neues Vorkommen von Bloedit-krystallen im Leopoldshaller Salzwerke: Von
 Dr. O. Leudecke. Presented by the Author.
 Ackererde und Untergrund von Franzenshütte. Von Prof. Dr. Carl Schmidt.
 Presented by the Author.
 Zur Dyas in Hessen. Von H. B. Geinitz. Presented by the Author.
 Verhandlungen des deutschen wissenschaftlichen Vereins zu Santiago. Heft. 3.
 Presented by the Society.
 Bulletin de la Société Française de Minéralogie. Tome IX. No. 5.
 Presented by the Society.
 Sur la Kirwanite et la Hullite; Propriétés optiques de l'Arséniosiderite; Propriétés
 optiques de quelques minéraux; Examen optique de l'hydrotéphroite et
 l'anthophyllite hydratée; Propriétés optiques de la Grünerite; Du
 Chloritoïde; Etude minéralogique du gabbro à anorthite de Saint-Clément;
 Sur un minéral probablement nouveau dans le guano du Perou; Identité de
 la Dréelite et de la Barytine; Propriétés optiques de la Warwickite et de la
 Withamite; Pléochroïsme de la Thulite; Contributions à la connaissance des
 propriétés optiques de quelques minéraux; Sur l'albite des Pegmatites de
 Norwège; Note sur les Anthophyllites; and Description d'une Variété de Car-
 phosidérite. All by M. A. Lacroix. Presented by the Author.
 Publications de l'Institut Royal Grand Ducal de Luxembourg. Tome XX., 1886.
 Presented by the Institute.
 Atti della Reale Accademia dei Lincei. 1886; Fasc. 1 to 9, 1st Semestre, 1887.
 Presented by the Academy.
 Atti della Società Toscana di Scienze Naturali: Processi verbali, Vol. V. pp. 80-118.
 Presented by the Academy.
 Bolletino del R. Comitato Geologico d'Italia, Nos. 5-8, 1886.
 Presented by the Commission.
 Annales de la Sociedad Científica Argentina. Marzo-Julio, 1886.
 Presented by the Society.

THE MINERALOGICAL MAGAZINE

AND

JOURNAL

OF THE

MINERALOGICAL SOCIETY.

No. 34.

JULY 1887.

Vol. VII.

On a Meteoric Iron found in 1884 in the Sub-district of Youndegin, Western Australia, and containing Cliftonite, a cubic form of Graphitic Carbon.

By L. FLETCHER, M.A., F.C.S., President.

[Read January 11th, 1887.]

THIS iron was found on January 5th, 1884, by Alfred Eaton, a mounted police constable, when on duty in the sub-district of Youndegin, at a spot distant about 60 chains (three-quarters of a mile) in a north-west direction from the top of Penkarring Rock, and roughly estimated by him as 70 miles east of York, Western Australia; this must be about longitude $117^{\circ}30'$ E. of Greenwich, latitude $31^{\circ}30'$ S. Only one of four observed fragments having been brought in by Mr. Eaton, the late Captain Smith, Commissioner of the Police at Perth, sent him out to Penkarring with a native assistant with instructions to bring in the other three, at the instance of the Rev. Charles G. Nicolay, Curator of the Geological Museum, Fremantle, to whom the late Mr. Edward T. Hardman, F.C.S., the Government Geologist, had expressed his belief in the meteoric origin of the iron. Eaton and his companion started off on horseback at 8 a.m. on February 8th, encamped at a "rock hole" for the night, and leaving at 6 a.m. the next day reached Penkarring at 7.30 a.m. An unsuccessful search was

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made for fragments additional to those already observed. Leaving Penkarrig at 7 a.m. on 1st March, they encamped at Morecanning for the night, and arrived at York Police-station at 7 o'clock on the following morning.

To the zeal and thoughtfulness of Mr. Nicolay we are indebted for the preservation of the specimens, and for the particulars of their discovery : by him, at the suggestion of Lady Barker, the largest and the smallest fragments have been generously presented to the British Museum through Mr. R. H. Scott, F.R.S., as Secretary of the Mineralogical Society.

The four fragments were lying loose on the surface, three of them close together, and the fourth about 15 ft. away : they weighed $25\frac{3}{4}$ lbs., 24 lbs., $17\frac{1}{2}$ lbs. and 6 lbs., respectively : in the opinion of Mr. Nicolay they seem to have formed a portion of a spherical mass, although they are individually irregular in shape. Scattered around the iron there were broken pieces, apparently belonging to a shell or outer covering, and of these a weight of 17 lbs. was collected. As the latter fragments consist essentially of magnetic oxide of iron, they are doubtless due to the action of the weather on the meteorite : the samples sent to the Museum have a laminated structure, and one of them is an inch in thickness.

The country around Youndegin is described as granitic with dykes of quartz, and schistose rocks : there is a superficial covering of sandstone, in which, though widely distributed over the Colony, no fossils have yet been found : there is no appearance of iron ore at Youndegin, though in many parts of the Colony iron ores are found in abundance. The above circumstances indicate an extra-terrestrial origin for the iron.

The only meteoric iron previously discovered in Australia is that of Cranbourne, near Melbourne, 1,500 miles distant from Youndegin.

The largest of the two fragments presented to the British Museum weighed $25\frac{3}{4}$ lbs. : it is 12 inches long, 10 inches broad, and has a maximum thickness of 3 inches. In shape it is rudely convex at one side and concave at the other ; its surface presents numerous spherical depressions. It is distinguished from all the meteoric irons in the British Museum collection by two cylindrical holes, completely traversing the iron from back to front : one of them has a diameter varying from 2 to $2\frac{1}{4}$ inches, and a length of $1\frac{1}{2}$ inches ; the other is of nearly the same size : three similar annular openings characterise the iron of Tazewell, Claiborne County, Tennessee, U.S.A., described and figured by the late Professor Lawrence Smith.¹ The large Signet iron, preserved in the National Museum at

¹ *Amer. Journ. Sc.* 1855, Ser. 2, Vol. 19, p. 154.

Washington, is an almost complete ring¹: the meteoric iron of Independence County, described lately by Mr. Hidden,² is likewise remarkable for the presence of a small hole.

The smallest fragment of the Youndegin iron, weighing 6 lbs., also in the British Museum, is likewise concavo-convex, but is without holes: it is 7 inches long, $4\frac{1}{2}$ inches broad, and about 2 inches thick.

The fragment weighing 24 lbs. is similar to the last mentioned; it is $9\frac{3}{4}$ inches long, 6 inches broad, and 4 inches thick: it is to be preserved in the Geological Museum, Fremantle.

The remaining fragment weighing $17\frac{1}{2}$ lbs. has been presented to the Melbourne Museum, Victoria.

The specific gravity was determined from three small pieces of the larger fragment, freed from rust; the numbers obtained were 7.86, 7.85, and 7.72 respectively.

The large specimen was cut on the premises of the Museum by means of hack-saws, and was found to be so hard that three weeks were required for the severance of a fragment of which the cut face is not $2\frac{1}{2}$ inches square: a larger section of another meteoric iron (Nejed) was made in one-third of this time. The surface was next worked down with hard files of increasing fineness, and lastly polished with felt and emery powder.

On this face are seen numerous sections of enclosures, mostly tabular, of a yellowish metallic mineral which is strongly attracted by a magnet: this was found to be schreibersite (phosphide of iron and nickel): some of the enclosures are in parallelism, and parts, isolated on the surface of the iron, are lineally arranged: the edges of the plates are only approximately straight: starting from them, thin cracks containing Schreibersite traverse the surface of the section in irregular directions: one of the plates is an inch long and one-eighth of an inch thick.

No stony matter is visible on the polished surface.

Relative to copper sulphate the iron is almost immediately active.

After exposure to the action of bromine water or dilute nitric acid the section gives no definite figures, but assumes a damascene appearance, very like that of the Tucuman iron, and of some parts of that of Brazos: to the latter iron it is very similar in the proportion and distribution of the schreibersite: the British Museum sections of the Arva and Sarepta irons are also, in parts, somewhat similar to it in their general characters.

On warming a fragment, weighing 7 grams, in dilute hydrochloric acid,

¹ Ibid. p. 161.

² *School of Mines Quarterly*, Vol. 7, No. 2, Jan. 1886.

the greater part dissolved, and there was left a small residue (56 milligrams) of yellowish metallic scales which are very strongly attracted by a magnet and contain phosphorus: they are doubtless Schreibersite, and identical with the enclosures visible on the polished surface.

None of the cubic crystals, described below, were present in this residue.

No sulphuretted hydrogen was detected in the gas evolved during the solution of the iron; this indicates the absence of troilite from the fragment under examination.

The sulphur precipitated on passing sulphuretted hydrogen into the solution was faintly brown: the colouration was found to be due to traces of copper, the constancy of which as an ingredient of meteoric iron has been insisted upon by Lawrence Smith.

Besides iron, only nickel, cobalt and magnesium, were found in the solution.

As the iron was too hard for its filings to be used as material for quantitative analysis, a large fragment, containing visible Schreibersite, was filed until free from rust: its weight was 8.3200 grams: its specific gravity, at $14^{\circ}5$ C., relative to water at 4° and allowing for displaced air, was 7.851 (uncorrected 7.86).

The fragment was dissolved in aqua regia in a porcelain dish, and evaporated to dryness, on the water-bath: the residue was treated with strong hydrochloric acid, and again brought to dryness to expel the remaining traces of nitric acid: on warming with water containing some hydrochloric acid, it was found that there was a small insoluble residue, consisting wholly of minute bright opaque greyish-black cubic crystals with metallic lustre. The solution itself was poured into a weighed double filter,¹ and the crystals were washed by decantation, the washings being passed through the double filter: the filter showed no change of weight. The weight of the crystals was found to be 3.1 milligrams.

The filtrate was made up to 1,000 cc., and portions, 125 cc. each, were removed by means of pipettes.

In one portion sulphuric acid was sought for, but not a trace was found, indicating the absence of troilite from this fragment also.

Another portion was evaporated to dryness on the water-bath, and afterwards heated in an air-bath for three quarters of an hour, at a temperature of 140° — 145° C.: no silica was obtained. The phosphoric acid in this portion was next concentrated in the manner recommended by

¹ *Original Researches*, by Lawrence Smith, 1884, p. 312.

Lawrence Smith, precipitated as phospho-molybdate,¹ dissolved in ammonia, and weighed as magnesium pyrophosphate.

From a third portion the iron was separated by a double precipitation with sodium acetate, redissolved in hydrochloric acid, and reprecipitated with ammonia.² After ignition it was reduced by heating in a current of hydrogen, and dissolved in dilute hydrochloric acid: in experiments on different portions variable minute quantities of silica were at this point obtained, and were derived probably from the re-agents.

The nickel and cobalt were separated from the magnesium by ammonium sulphide, and weighed together both in the oxidised and metallic condition: after solution of the nickel and cobalt the latter was precipitated by potassium nitrite, and weighed as potassium cobalt sulphate.

In this way the composition of the iron was found to be as follows:—

Iron	...	...	...	...	...	92.67
Nickel	...	...	...	...	...	6.46
Cobalt	...	...	...	...	...	0.55
Copper	...	...	...	...	...	trace
Magnesium	...	...	...	...	...	0.42
Phosphorus	...	...	...	...	...	0.24
Sulphur	...	...	...	...	...	none
Insoluble cubes	...	...	...	...	...	0.04

Total 100.38

If the phosphorus be assumed to be wholly present in combination with iron and nickel, as Schreibersite, with the formula $\text{Fe}_2 \text{Ni P}$ and percentage composition Iron 55.53, Nickel 29.09, Phosphorus 15.38, the above will correspond to:—

Nickel-iron	...	...	...	...	98.82
Schreibersite	...	...	...	...	1.56

100.38

As no opaque greyish-black mineral with a metallic lustre, and insoluble in aqua regia, is recognised as occurring in cubic crystals, the satisfactory determination of the nature of the insoluble residue of 3.1 milligrams was expected to be a matter of some difficulty: further, two fragments of the iron, weighing 7 grams and 2 grams respectively, had not yielded a single crystal, and there was thus a possibility of the crystals being so localised as to render impracticable an increase of the quantity of material available for experiment.

¹ *Amer. Jour. Sc.* 1882, Ser. 3, Vol. 23, p. 316.

² *Select Methods in Chemical Analysis*, by Crookes: 2nd edition, p. 517.

³ *Ibid.* p. 272.

The crystals were about a hundred in number, the average thickness of the larger ones being one-fourth of a millimeter (one-hundredth of an inch).

On all the crystals the faces of the cube are predominant : many are sharply defined simple cubes ; some have their edges truncated by faces of the dodecahedron, as was proved by measurement on the goniometer ; in others the edges are replaced by rounded faces of a tetrakis-hexahedron ; or again, one or more of the cube-faces is replaced by a very obtuse, almost flat, square pyramid. One of the cubes shows re-entrant edges, suggesting a lamellar growth. A little group of three parallel crystals was observed.

One of the crystals having been dropped on to a thin layer of red sealing wax melted on a glass plate, was held sufficiently firmly by the cooled wax to allow of its hardness and streak being determined. The hardness is greater than that of rock-salt, and less than that of calcite : it may be expressed as 2.5. The streak on white unglazed porcelain is black and shining.

The crystals are not affected by a magnet.

Of four crystals, two sank to the bottom, and two floated near the surface of a solution of specific gravity 2.12.

The crystals remain unaltered when heated in a glass tube, closed at one end.

They are unattacked by nitro-hydrochloric, sulphuric, or hydrofluoric acids.

They float unaltered in beads of borax, microcosmic salt, or sodium carbonate, held in a blowpipe flame.

On dissolving in water a bead of sodium carbonate and potassium nitrate, in which three of the crystals had been heated, only one crystal was seen, and this was much reduced in size : the solution of the bead gave no evidence of the presence of chromium.

Similar beads, in each of which a crystal had been dissolved, were tested for phosphoric and silicic acids with negative results ; nor did the solution of a bead in hydrochloric acid give any precipitate with ammonia, ammonium sulphide, ammonium carbonate, or sodium phosphate.

Heated in a combustion tube in a current of oxygen, hydrogen or chlorine, they are unattacked, even when the glass begins to melt.

Heated in a long narrow porcelain crucible in air or oxygen with the table-blowpipe they appear unaltered, but in a shallow uncovered platinum capsule or small porcelain crucible they slowly disappear, without flame : from the platinum capsule the disappearance was complete, but in the

porcelain crucible there was sometimes left an almost imperceptible black residue : projecting from this, in one instance, minute fibres were seen with the microscope.

Heated with potassium nitrate in a crucible over a Bunsen burner they are unattacked, but disappear very slowly, without deflagration, when heated with the table-blowpipe.

In density, colour and streak, and in its chemical behaviour, the residual mineral thus resembles native graphite, but it is considerably harder, and presents itself in well-defined crystals which belong, like the other crystallised form of carbon, the diamond, to the cubic system : terrestrial graphite, when crystallised, is found only as tabular crystals so indistinctly formed that doubt has long existed as to whether they should be referred to the hexagonal or monosymmetric system.

From other fragments of the iron, weighing altogether about 10 grams, thirty more of the cubic crystals were obtained.

Graphitic carbon, sometimes in large nodules, has been found concreted in several meteoric irons, and has been subjected to careful examination by Lawrence Smith :¹ in structure and powder it is not unlike the compact Borrowdale graphite, and differs completely both from the scaly graphite found native and from that which is presented by certain cast irons ; on the other hand, its conversion into graphitic acid by oxidising reagents is more rapid than that of any terrestrial native graphite experimented upon by him.

In a paper entitled " Graphite, pseudomorphous after Iron Pyrites," Haidinger,² in 1846, described some graphitic crystals which are doubtless identical in their general characters with those furnished by the Youndegin iron : his observation, however, has been forgotten, and is without record in modern meteoric literature. The crystals, of the size, number, and completeness of which Haidinger makes no mention, were obtained by him from a nodule of graphite which had dropped out of the Arva meteoric iron : impressed by the similarity in shape of the nodules of graphite and sulphide of iron present in this meteorite, and by the circumstance that the two minerals are occasionally lying side by side, Partsch conceived the idea that one was pseudomorphous after the other ; and Haidinger and Partsch became convinced of the correctness of this idea by the form of the graphitic crystals, on the cube-edges of which they believed there were faces of the pentagonal dodecahedron $\pi \{120\}$, so common a feature of the crystals of iron pyrites. Of the incorrectness of this explanation

Amer. Jour. Sc. 1876, Ser. 3, Vol. 11. p. 388. ² *Pogg. Ann.* 1846, Vol. 67, p. 437.

of the graphitic crystals there can be no doubt: the presence of iron pyrites, crystallised or massive, has even yet not been established for any meteorite; the meteoric sulphide of iron being not the bisulphide but the protosulphide, and having since received from Haidinger himself the specific name of troilite (1863).

Nor is Haidinger's interpretation of the form of the Arva graphitic crystals beyond criticism, for Gustav Rose,¹ to whom the crystals had been kindly sent for inspection, expressed an opinion that the mode of replacement of the cube-edges was suggestive rather of holo-symmetry than of hemi-symmetry—an interpretation which would exclude iron pyrites as a possible antecedent mineral.

The Younegin graphitic crystals support the view entertained by Rose: the existence of the dodecahedron-face, of which there is goniometrical proof, is of itself quite sufficient to show that the crystalline form is distinct from that of iron pyrites. The iron pyrites theory being abandoned, and the fact being recognised that no mineral constituent of meteorites has yet been found which crystallises in forms similar to those of the graphitic crystals, there naturally arises a feeling of doubt as to the correctness of the view according to which they are of pseudomorphic origin, and a question as to whether they do not represent a third allotropic condition of crystallised carbon: it is conceivable, in fact, that the explanation by pseudomorphism really resulted from the supposed similarity of the form of the crystals to that of iron pyrites.

Bischof² denies the possibility of explaining the pseudomorphism of terrestrial minerals by any other process than the slow action of water, of which there is no evidence in meteorites; and though it would be unsafe to argue that only in this way could meteoric pseudomorphs be produced, there is sufficient difficulty in accounting for the occurrence of pseudomorphs in the interior of a mass of iron to compel us to demand strong evidence before the pseudomorphism of the graphitic crystals is granted, more especially when we have regard to the fact that no other graphitic pseudomorph has yet been established either in meteoric or in terrestrial minerals.

The Younegin crystals were accordingly examined under the microscope with a quarter-inch objective. One of the dodecahedron-faces, an elongated hexagon in shape, showed ridges symmetrical to the truncated edge of the cube, and parallel to the two short edges of the hexagon which meet in

¹ *Beschreibung und Eintheilung der Meteoriten*, 1864, p. 40. *Pogg. Ann.*, 1873, Vol. 148, p. 516.

² *Chemical and Physical Geology*, 1854, Vol. I. p. 33.

one of the trigonal quoins. From the faces of several of the crystals spring acutely conical, almost acicular, projections of the same material, more or less irregular in shape: sometimes there is an approximately spherical growth covering a greater part of a cube-face, and occasionally one of the spherical growths is broken, and is seen to be merely a thin, now empty, shell, of which the bottom is the face of the cube: in shape this is suggestive of a burst bubble. One specimen was apparently a fragment of a hollow cube.

The crystals are easily frangible; one of them, when gently pressed between a glass plate and a sheet of paper, was flattened out and was split parallel to the edges of one of the cube-faces, as if the crystal had been hollow and had collapsed. Examined under the microscope, one of the thin fragments was found to consist of several distinct layers parallel to a cube-face, and on its interior surface was seen a bright triangular face in the zone of a cube-edge: another thin square fragment, doubtless a face of the original cube, has a granulated internal surface, and its edges are bent at right angles to its plane, as if it had formed a portion of a shell. The powder of this crystal was scaly, and gave a scarcely visible streak on the paper. Three other crystals were found to be solid. No cleavage surfaces were visible on the fragments.

The crystals appear to be quite homogeneous in their material.

Although some of these characters point, more or less distinctly, to a pseudomorphic origin of the crystalline form, it cannot be said that they suffice to establish it. The easy frangibility, the absence of evidence of cleavage, the hollowness, and the occasionally crust-like structure, though such as are common in pseudomorphic minerals, are not incompatible with the idiomorphism of these crystals: hollow and skeletal forms, indeed, are frequently a result of a hurried crystallisation, as is so well seen in the artificial crystals of bismuth and of sodium chloride. On the other hand, while the hardness indicates a difference of the material from native graphite, the sharpness, separateness and completeness of the crystals, the brightness of the faces, the delicacy of the acicular projections, and especially of the obtuse, almost flat, square pyramids on some of the faces, are sufficient to prove that the form has never had any other than its present parent, and that we have here an allotropic condition of crystallised carbon distinct from both diamond and graphite. And we may add that both of the recognised crystallised forms of carbon have long been standing difficulties for the crystallographer: as already pointed out, crystals of graphite are rarely more than mere tables of which there is a controversy as to the crystalline system, and those of the diamond are so different in their geome-

trical characters from the crystals of every other known substance that it cannot be satisfactorily determined whether they are to be referred to a holo-symmetric or to a hemi-symmetric type.

If it had been conceivable that the above characters, and the occurrence in the interior of meteoric iron, are compatible with a change in the material since the first development of the crystalline form, it would have been more easy to imagine that the change has been one of molecular re-arrangement than of substitution, and that the crystals were originally cubes of diamond. In fact, the diamond, when in cubes, has faces not very unlike those of the Youndegin crystals, and shows usually a similar bevelling of its edges by rounded faces of tetrakisshexahedra. Or, again, it might be argued that during a hurried crystallisation of the carbon, the circumstances, though initially favourable to the formation of diamond, had finally only permitted of the existence of the carbon in a graphitic form.

The nature of the faces, the obtuse pyramid, the spherical growths, the acicular projections, and the parallel groups, are different, however, from anything ever met with in the diamond.

On examination of a large nodule of graphite from the Cocke (or Sevier) county iron, now in the British Museum collection, distinct graphitic crystals, cubo-octohedral in form, were found to be present.

As this kind of crystallised graphitic carbon is unknown among terrestrial minerals, and has so important a bearing on the formation of meteoric graphite, it may conveniently receive a distinctive name, and I therefore suggest the term *Cliftonite*—after Mr. R. B. Clifton, M.A., F.R.S., Professor of Physics at Oxford, who has long interested himself in the physical characters of minerals, and has given great encouragement to their study.

Supplementary Note on Felspar from Kilima-njaro. (Ante p. 11.)

By L. FLETCHER, M.A., F.C.S., and H. A. MIERS, M.A., F.G.S., of the Mineral Department, British Museum.

[Read January 11th, 1887.]

A CHEMICAL analysis of this felspar, to which our attention was directed by Professor Bonney,¹ and which was subsequently described² on crystallographic and optical grounds as orthoclase, shows it to be a soda-potash felspar of somewhat peculiar composition.

In the following table, the first two columns give the results obtained on analysis (Fletcher) of two loose crystals, of which the second was a twin-crystal of lighter colour than the first; the next two columns represent the same analyses if the oxide of iron (present as visible enclosures) and the loss on ignition are neglected; the numbers in the fifth column are obtained by taking the means of the numbers in the two preceding columns. For the sake of comparison the composition of felspars from Svenoer³ and Tyveholmen⁴ is given in the last two columns.

	Kilima-njaro.					Svenoer.	Tyveholmen.
	1st. Crystal.	2nd. Crystal.	1st. Crystal.	2nd. Crystal.	Mean.	Vogt.	Fischer.
Silica	60.52	61.03	62.59	61.74	62.17	61.35	61.90
Ferric Oxide ..	2.96	1.68					
Alumina	22.29	23.71	23.06	23.98	23.52	22.37	23.59
Lime	2.77	2.91	2.86	2.94	2.90	4.66	5.26
Magnesia	trace	trace				0.04	
Soda	6.48	6.83	6.70	6.91	6.80	6.59	2.60
Potash	4.63	4.38	4.79	4.43	4.61	4.97	6.64
Loss on ignition	0.18	0.24					
	99.83	100.78	100.00	100.00	100.00	99.98	99.99

The Oxygen ratio of the Kilima-njaro felspar is therefore

$$9.86 : 3.29 : 1$$

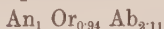
¹ Bonney. *Rep. Brit. Ass.* 1885, p. 682.

² Miers. *Min. Mag.* vii. p. 11.

³ Brögger. *Die Silurischen Etagen 2 und 3.* 1882, p. 261.

⁴ Mügge. *Neues Jahrbuch.* 1881 (2), p. 106.

If expressed as a mixture of Anorthite, Microcline, and Albite substance, this feldspar would be represented as



A re-determination of the optical and crystallographic characters (Miers) affords no proof that the crystals are not mono-symmetric. The angle between the cleavages is 90° (the deviation being never greater than $16'$), and double images are given by b ($=M$) as frequently as by p .

The angle of extinction in clino-pinacoid sections is $4^\circ 20'$ in the positive direction; in sections perpendicular to the clino-pinacoid the directions of extinction are parallel and perpendicular to that face

$$2 E = 102^\circ, 2 H_a = 64^\circ, 2 H_o = 129^\circ 30',$$

therefore $2 V = 60^\circ 44'$; $\beta = 1.5373$. (Sodium light.)

The acute bisectrix is negative. The obtuse bisectrix is positive.

Examination of a thin section cut perpendicular to both cleavages shows that the cross-hatching, referred to by Prof. Bonney and in the previous note, is formed by a vertical series of extremely fine lines intersected by a horizontal series of shadowy bands, both series being only visible near the position of general extinction between crossed nicols; each vertical line remains light on one side of this position, and becomes dark during a considerable rotation on the other side; it is impossible to assign any definite extinction angle; the average inclination to the vertical is about 10° . These lines have not the continuity of twin-lamellæ, they sometimes taper at the ends, and their general appearance suggests something more akin to microcline structure; there is no trace of them in sections parallel to the basal plane.

The spots alluded to in the previous note are seen in thinner sections to be glass enclosures, similar to those in oligoclase from Pantelleria (Rosenbusch, *Mikr. Phys.* 1886, Plate vii. fig. 3); there are also inclusions of the ground-mass, numerous crystallites, and a little apatite. This feldspar therefore bears some resemblance to those of Tenerife,¹ Mt. Esterel,² Pantelleria,³ and especially to the feldspars from the Svenoer Augite-Syenite and the Tyveholmen "Rhombenporphyr" (quoted above), a group with reference to which the names oligoclase, soda-orthoclase, soda-microcline, and anorthoclase⁴ have been employed. Mügge⁵ has lately described the feldspar from the recent eruptive rocks of L. Naiwascha, Massai-land, a locality not far distant from Kilima-njaro, under the name of soda-microcline.

¹ Deville. *Comptes Rendus*, 19, 1844, p. 46.

² Rammelsberg. *Min. Chem.* 1875, ii. p. 569.

³ Förstner. *Zeits. f. Kryst.* viii. 1884, p. 125.

⁴ Rosenbusch. *Mikro. Phys.* 1885, p. 550.

⁵ *Neues Jahrbuch.* Beil. Bd. 4, 1886, p. 291.

On the Occurrence of Greenockite at a New Locality.

By Prof. HEDDLE, F.R.S.E., &c.

[Read January 11th, 1887.]

MORE than a year ago I obtained a number of minerals in Boylestone quarry, which lies about a quarter of a mile north-west of Barrhead, near Glasgow.

Upon breaking up at home the very unwieldly druses which alone seem to occur at this locality, I found one which contained *Greenockite*.

A single bright yellow crystal only occurs, and it lies so deep in the specimen, between two mammillations of prehnite, that its form cannot be deciphered.

I was induced by the urgent solicitations of a local collector, to whom I mentioned the find, to refrain for a time from announcing it. His argument was that the mineral collectors of the neighbourhood should have the earliest chance of being supplied.

As I have myself fruitlessly visited the quarry since, and as even the occurrence of the ordinary zeolites is only very occasional therein, I conclude that time must elapse before more crystals are turned out.

The rock-matrix, mode of occurrence, and mineral associates are here the same, or much the same, as occur at the other Scotch localities for this very rare substance.

The quarry is wrought for the most part for road metal; the rock is a friable dolerite, so soft as occasionally to have an almost wackenitic appearance. It is pervaded more by inosculating fissures than by well defined steam-holes; and these fissures are plugged for the most part by calcite.

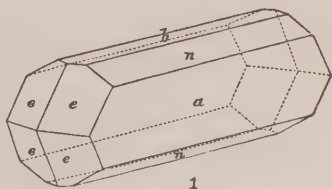
Such a rock gives but little promise of zeolites. Olivine, however, occurs in abundance, and the finest crystal of that mineral which I have seen from Scotland was found here by Mr. John Young, the Curator of the Museum of the Glasgow University.

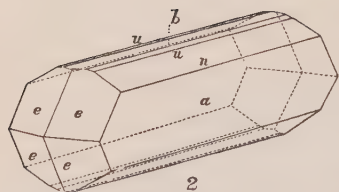
Its form is $n a b c$. (Fig. 1.)

It was about the same thickness, but only about one-third of the length of the figure.

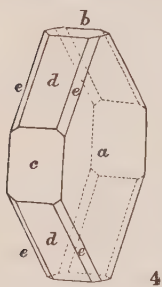
Figure 2 (p. 134) is a form in much smaller crystals observed by myself, chiefly in the denser portions of the rock.

In February 1882 I gave in this





suffered change. In the immediate neighbourhood of Boyleston, and along the whole stretch of hill-face from Hatfield-Moss through Gleniffer to Fernese, the dolerite is studded with large crystals of twinned labradorite, and crystals of olivine in the form of figure 4.

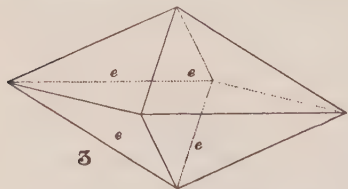


This I find is the form of "ferrite," for not only are unaltered crystals of olivine in this form found, but also crystals in every stage of alteration with the brown and soft clay-like "ferrite." In ferrite the brachy-diagonal cleavage is perhaps still the most eminent, but the process of transformation of substance has exalted the macro-diagonal originally imperfect cleavage to a

great extent.

Though both the above forms of olivine occur in close association, it is singular—at least, in the absence of an analysis of each we may say that it is singular—that it is only the mineral which occurs in the form of figure 4 which is changed into "ferrite."

This "ferrite" of Wallace Young is undoubtedly a substance differing altogether from that recognised by micro-petrologists under that name; and as Young's mineral had not only been analysed but fairly well described, and "held the field" long before the other, it is a pity that the ordinary scientific law has here been departed from in applying the same name to a new substance.



In order to illustrate the extreme diversity of form in which olivine, though rare in crystals of any size, is found in Scotland, I give the figure of crystals from the north-east end of the Kincaig at Elie in Fife. These crystals occur imbedded in a dense

and tough blue-black basalt, and they are some inches in length. Their structure is granular, with so loose attachment of the granules that when exposed they are represented frequently only by hollow casts.

The only other locality at which I have seen crystals of olivine large enough to be figured, was the north side of the Bay of Talisker in Skye. The crystals are like figure 4, but without the faces *c* and *e*.

A granular crystal of huge dimensions was also found here by Mr. Peyton. Its form was like that of fig. 1 of Naumann, but its faces were rough, and it fell in pieces during the extraction.

A massive band of basaltic rock cuts the quarry in an east and west direction. This yields, though only very occasionally, large druses of analcime, also of prehnite with other zeolites; but, from the large size of the druses, the extreme toughness of the rock, and the feeble attachment of the zeolites thereto, it is with extreme difficulty that undefaced specimens can be obtained of a size suitable for cabinets.

I speak of what obtains at present, as, in the collection of Mr. D. C. Glen, there are several specimens fair in form and shape.

Where the amygdaloidal rock passes into basalt, which it does by insensible gradation, *native copper* is of frequent occurrence.

It is generally in very thin plates, which, being more or less extended in a single plane, seem to have filled rents; but the perfect continuity of the rock around the fringes of these plates, and their unusual brilliancy of colour, altogether preclude the conclusion that the copper was transfused into *pre-existent* fissures.

But seldom have these plates a thickness much greater than that of foil, though masses of about seven ounces have been found. The brilliancy of lustre disappears, and there is also a darkening of colour in the course of a few days. Minute crystals of copper also occur imbedded in clear crystals of calcite.

The zeolites which are found in this quarry occur for the most part in the dense basalt.

Prehnite is very much the most abundant. It usually forms large druses with mammillated groupings of crystals, which do not stand free or isolated at their terminations. The colours are for the most part of a dull green; but specimens of a bright green and also almost of a sulphur-yellow are occasionally found. The brighter green colours are evidently due to copper; minute distorted crystals and filaments of which, coated with powdery malachite (?), sometimes protrude from the surface of the prehnite. The cause of the colour of the yellow specimens is not evident.

That the prehnite is not the earliest formed of the zeolites is evident, for the sulphur-coloured prehnite, which is generally in isolated spheres, is disposed on the surface of analcime. The centres of the larger

masses of prehnite are colourless ; and disposed throughout the green, or mixed with opaque white, there are blotchings of a pink or somewhat lavender tint. Slabs of this when polished are not unpleasing as brooch stones.

I have seen no free crystals of prehnite in this quarry.

The *analtime* is opaque milky white ; it occurs in grouped crystals of the form *n*, from one-quarter to three-quarters of an inch in size. The specimens are as fine of the white variety as any in Scotland. Distorted crystals occur ; the distortion being a shortening along the octahedral axis.

Small opaque isolated crystals of a beautiful flesh colour also occur.

Thomsonite occurs of two varieties. Grouped bunches of radiating acicular crystals embedded in analtime ; and fan-shaped groups of diverging flat crystals which stand free from the surface of clustered crystals of analtime. The former of these varieties is in crystals two inches in length—these have no terminations ; the latter are about one inch by an eighth of an inch in thickness. These have the unusual development of faces figured. (Fig. 5.)

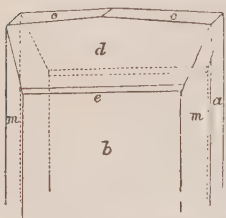


FIG. 5.

Lying upon the surface of the prehnite there rarely occur groupings of interlacing but isolated crystals of *natrolite*, disposed upon the sides of the crystals, loosely attached and sometimes doubly terminated. The crystals are nearly two inches in length, but only about a thirty-second in thickness. Although they have only the ordinary form *m c*, they are probably the finest found in Scotland.

Poor specimens of *Laumontite* occur.

In 1855 I announced the occurrence of the scaly variety of Göthite termed *rubin-glimmer* along with zeolites at Kilpatrick ; the same substance occurs here in groups of rosette-like crystals. It was by some taken for crystallised native copper ! This crystal-bloom attaches itself only to the analtime and to the Thomsonite, but it sometimes lies as a scaly down on the surface of crystals of *calcite*.

These last occur, though rarely, in several fine and highly complex forms which I am at present figuring. They sometimes are two inches in length.

Notwithstanding the apparent richness of this locality, it is one which cannot yield many specimens for the cabinet, unless the lapidaries' wheel be used for the fashioning of them ;—even a well-skilled hammerer producing only uncouth and shapeless specimens.

The chief interest connected with this quarry is in the zeolites being

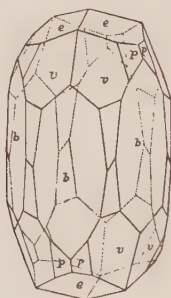
solely of the lime and soda class, and this is clearly explained by the abundance of *labradorite* in the unchanged rocks of the neighbourhood. *Saponite*, however, occurs as a decomposition product, filling the smaller drusy hollows.

On a Form of Calcite from Heilim, Sutherland.

By Prof. HEDDLE, F.R.S.E., &c.

[Read January 11th, 1887.]

THE form of Calcite depicted in the figure occurs in the quarries which were for some time worked in the dolomite of the semi-peninsular islet at Heilim, on Loch Erribol, Sutherland.



Cavities in the rock are rare, and well developed forms of calcite still more so.

The only other forms which I noticed were the common "nail-head" and the "dog-tooth,"—the latter being somewhat modified.

The dolomitic constitution of the rock is against the formation of distinct crystals, which I do not remember to have seen elsewhere in its long stretch southward to Applecross.

The crystal drawn is interesting from the nearly equal balancing of its component forms in a combination which I have not seen before figured.

Note on the Occurrence of Bismutite in the Transvaal.

By HENRY LOUIS, A.R.S.M., F.I.C., &c.

[Read January 11th, 1887.]

THIS mineral occurs plentifully, though finely disseminated, in the veins of auriferous quartz in the Lydenburg district of the Transvaal. These veins are often capped by a "gossan" of brown hæmatite, crystalline, amorphous, or at times pseudomorphous after iron pyrites; a good deal of similar brown hæmatite occurs also throughout the veins themselves. The Bismutite is disseminated irregularly through the veins, and also occurs in small pockets in the ferruginous gossan; it is from the latter source that the mineral was obtained for the subjoined description and analysis.

It is amorphous, pulverulent; colour greenish yellow to lemon-yellow, more rarely brownish yellow; opaque (feebly translucent, with waxy lustre under the microscope); its hardness appears to be about 3, but cannot well be determined on account of its pulverulent character. Specific gravity 6·86. The following is an analysis of it (great accuracy could not be attained as the quantity to be operated on was very small):—

Insoluble matter (quartz)	...	...	...	...	0·9
Bi ₂ O ₃ ...	...	...	...	...	79·6
CO ₂ ...	...	...	...	...	7·2
H ₂ O ...	...	...	...	...	2·7
Oxide of iron, traces of lime, etc.	...	...	...	...	9·6 ¹
					100·0

This analysis gives as the percentage composition of the Bismutite itself, the following:—

Bi ₂ O ₃	...	...	...	88·95
CO ₂	...	...	...	8·04
H ₂ O	...	...	...	8·01
				100·00

¹ No other heavy metals except Bismuth were present.

This composition gives for the mineral the formula $\text{Bi}_2\text{H}_2\text{CO}_6$, or $\text{Bi}_2\text{H}_6\text{O}_6 + (\text{Bi}_2\text{O}_3)_2, 3\text{CO}_2$. This formula differs somewhat from that hitherto assigned to Bismutite, but corresponds well with the composition of the mineral here described, the percentage composition demanded by the above formula being

Bi_2O_3	...	...	..	88.22
CO_2	...	...	...	8.36
H_2O	...	...	...	3.42
				100.00

It is worthy of notice that this is not the only instance of the paragenesis of Bismutite with auriferous quartz, as a similar occurrence has been recorded from South Carolina.

Apatite from a New Locality in Eastern Cornwall.

by R. H. SOLLY, F.G.S., Demonstrator in Mineralogy to the University of Cambridge.

[Read January 11th, 1887.]

IN the last Number of the Society's Journal I described some crystals of apatite (francolite variety) from St. Just district of Western Cornwall; I have now to bring to the notice of the members some very fine beautiful crystals of this same mineral which I have received from Mr. Henson.

In point of beauty and lustre they far surpass any of the apatites that have yet been found in England.

The crystals are in the form of hexagonal prisms, doubly terminated with basal planes and narrow pyramid planes; colour pale bluish green, translucent with strong vitreous lustre.

They vary in size from a pin's head to half-an-inch across.

The following forms are nearly always present:— o (111) well developed, i (231), x (120), z ($13\bar{1}$) narrow r (100), small r_1 ($\bar{1}22$), smaller a ($10\bar{1}$) well developed, b ($2\bar{1}\bar{1}$) smaller; the two latter planes deeply striated parallel to their intersection with one another.

The crystals are deposited in voynes in the granite associated with white felspar, dark brown tourmaline, gilbertite, smoky quartz, silvery mica and pseudomorphs of gilbertite after quartz. These so-called pseudomorphs by incrustation are nothing more than the remains of the coating of gilbertite on crystals of quartz, which have been afterwards either dissolved or broken away.

These crystals of apatite in their development resemble those fine dark blue crystals found at St. Michael's Mount more than fifty years ago, but in colour are closer to the Ehrenfriedersdorf, and in lustre to those brilliant crystals from Knappenwand, Untersulzbachthal, Salzburg.

The association of brown tourmaline with gilbertite I have not seen before in Cornwall. In other respects the matrix is very similar to that from Stenna Gwyn, near St. Austell.

Celestine from a New Locality in Gloucestershire.

By R. H. SOLLY, F.G.S., Demonstrator in Mineralogy to the University of Cambridge.

[Read January 11th, 1887.]

THE great similarity which exists in the crystallographic and optical constants, cleavage, and absence of twinning in the isomorphous rhombic sulphates is especially marked in Barytes and Celestine, but though the combination of forms is sometimes the same, yet up to the present time a marked individuality has been perceived in Celestine crystals which has made it easy to recognise the one mineral from the other.

The crystals of Celestine from near Bristol in the red marl, those associated with sulphur from Sicily, or the large flat more or less bluish tabular crystals from Strontian Island, Lake Erie, are varieties which are seldom if ever mistaken for Barytes.

But some fine large semi-transparent white crystals that have come into the hands of Mr. Henson, and which were quite lately found in Gloucestershire, resemble so closely in form crystals of Barytes from Dufton, Westmoreland, that it was only by measurement I was able to be sure of their identity. The following forms are present:—*c* (001) large, *o* (101), *d* (012) well developed narrow, *g* (013), and small *m* (110).

Another habit is also found on crystals from the same place; *c* and *m* largely developed with small *o* and *d*, closely resembling except in colour those crystals of Barytes from Frizzington, Whitehaven, Cumberland.

I believe I may further state that these last crystals are the largest by far that have yet been found of Celestine in this country, and in size remind one of the Lake Erie crystals.

Note on the presence of Lead in Calcites from the Leadhills District.

By J. STUART THOMSON, Esq.

[Read January 11th, 1887.]

THE not unfrequent occurrence of the variety of Calcite, containing Carbonate of Lead and known as "Plumbo-calcite," at the Leadhills district, suggested that an examination of some of the ordinary Calcites from this locality, for Lead, might be of interest. The specimens for this examination were most kindly put at my disposal by Dr. Wilson. All of them were ordinary Calcites, none consisting of the recognised Plumbo-calcite.

The following is a brief description of the specimens and the result of their analysis :—

No. 1. Locality: Bay-mine, Wanlockhead. Dog-tooth-spar, opaque, milky, appeared to be water worn.

No. 2. Locality: Bay-mine, Wanlockhead. Fine transparent scalenohedrons.

No. 3. Locality: Bay-mine, Wanlockhead. Similar to No. 2, but from a different part of the workings.

No. 4. Locality: Bay-mine, Wanlockhead. Fibrous, radiating, white.

No. 5. Locality: Beltongrain-mine, Wanlockhead. This consisted of two distinct growths of crystals, the larger and older generation (No. 5a) being crystallised after $+R$, while the smaller and more recent crystals (5b) were $-\frac{1}{2}R$, $+R$, $-nR$ (probably $-5R$ or $-8R$).

No. 6. Locality: Bay-mine, Wanlockhead, Fibrous, massive, white, translucent.

No. 7. Locality: Bay-mine, Wanlockhead. Rhombohedrons, white, edges stained dark brown.

No. 8. Locality: Leadhills. Large distinct crystals $-\frac{1}{2}R$ and $\infty P2$, white, translucent.

The following table shows the specific gravity and the amount of Carbonate of Lead found in the above specimens :—

	Sp. Gr.	PbCO ₃ .
No. 1	2.696	0.22 per cent.
„ 2	2.544	trace
„ 8	2.618	trace

	Sp. Gr.	PbCO ₃ .
No. 4	2·708—2·710	0·91
„ 5a	2·758—2·766	3·51
„ 5b	2·699	0·86
„ 6	2·688—2·724	0·79
„ 7	2·683	0·20
„ 8	not taken	none

Naumann gives the specific gravity of Plumbo-calcite as 2·772 to 2·824, while the PbCO₃ ranges from 2·34 per cent. (Delesse) to 7·74 per cent. (v. Hauer), and 7·8 per cent. (Johnston). The only one of the foregoing analyses which approximates to these figures is that of No. 5a. The results generally show that Lead is not unfrequently present in the Calcites of this district, and an examination of the Calcites from similar lead mining districts for lead would be of interest.

It may be noted that a specimen of Aragonite from Wanlockhead gave no indication of lead.

*the Use of the Gnomonic Projection ; with a Projection of the Forms of
Red Silver Ore.*

By H. A. MIERS, M.A.

[Read January 11th, 1887.]

If the planes of a crystal be replaced by lines drawn perpendicular to them through a point the intersection of the sheaf of lines so formed with the plane of the paper is the Gnomonic Projection of the crystal ; each face being represented by a point and each zone by a line joining such points. This projection, which has been frequently used and fully described, has generally been employed to represent the symmetrical disposition of the faces, the plane of the figure being a plane of symmetry.

But the practical value of the projection is best seen when it is used either as a graphic representation of the forms of a mineral, or as a method of drawing a perspective figure of any part of a crystal.

—To represent all the forms of a mineral (which does not belong to either of the two oblique systems) the plane of the figure must cut the whole group of normals enclosed within three adjacent planes of symmetry.

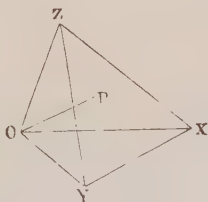


FIG. 1.

Let OX , OY , OZ (fig. 1), be any three normals, the angles between which are

$$YOZ = \xi$$

$$ZOX = \eta$$

$$XOY = \zeta$$

Let XYZ be the plane of the figure of which the normal OP is inclined to the first three normals at the angles

$$POX = \alpha$$

$$POY = \beta$$

$$POZ = \gamma$$

Let $OP=p$. Then

$$YZ=K. p \cos \alpha \sqrt{\cos^2 \beta + \cos^2 \gamma - 2 \cos \beta \cdot \cos \gamma \cdot \cos \xi}.$$

$$ZH=K. p \cos \beta \sqrt{\cos^2 \gamma + \cos^2 \alpha - 2 \cos \gamma \cdot \cos \alpha \cdot \cos \eta}.$$

$$XY=K. p \cos \gamma \sqrt{\cos^2 \alpha + \cos^2 \beta - 2 \cos \alpha \cdot \cos \beta \cdot \cos \zeta}.$$

where
$$K = \frac{1}{\cos \alpha \cdot \cos \beta \cdot \cos \gamma}.$$

And

$$PX=p \tan \alpha$$

$$PY=p \tan \beta$$

$$PZ=p \tan \gamma$$

Thus the triangle XYZ may be drawn, and the position of P may be laid down for any position of the plane of the figure at any required distance (p) from the origin.

Then any other point of the system being laid down from its known angles, the whole system of points corresponding to possible planes of the crystal may be mapped out by the intersections of lines joining these points.

The dihedral angles are measured on the projection by means of the "Circle of Projection" described from centre P with radius equal to p .

The following constructions are given in all descriptions of the gnomonic projection:—

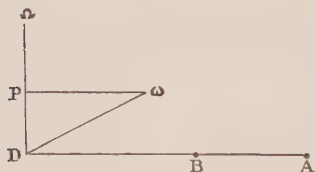


FIG. 2.

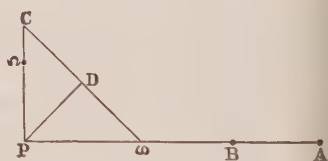


FIG. 3.

(1.) To find the angle between two normals whose projections are AB (fig. 2). Through P draw PD perpendicular to AB, meeting AB in D; draw $P\omega$ parallel to AB, meeting the circle of projection in ω . Along PD take $D\Omega=D\omega$. Then the angle between any pair of normals whose projections AB lie in the zone line ABD is the angle subtended by AB at Ω .

(2.) To find the angle between two zones whose projections are CA CB (fig. 3). Join CP; draw $P\omega$ perpendicular to CP, meeting the circle of projection in ω . Join $C\omega$; draw PD perpendicular to $C\omega$, and in PC take $P\Omega=PD$.

Then the angle between any pair of zones whose projections CA, CB intersect in the point C is the angle subtended at Ω by their intersections with $P\omega$.

With the help of these constructions any crystal may be easily projected.

In the systems with rectangular axes and in the Hexagonal and Rhombohedral system the construction of the figure is much simplified by a convenient choice of the plane of projection.

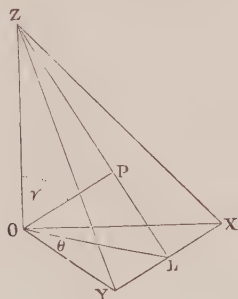


FIG. 4.

If OX, OY, OZ (fig. 4) are the rectangular axes in the former, or two lateral axes and the vertical axis in the latter,

$$\cos \alpha = \cos \beta = \sin \gamma \cos \frac{\zeta}{2} = \sin \gamma \cos \theta \text{ where } 2\theta = \zeta.$$

Let ZP meet XY in L; then $ZLX = 90^\circ$.

$$ZL = \frac{p}{\sin \gamma \cos \gamma} \quad \text{and} \quad XL = \frac{p \tan \theta}{\sin \gamma}$$

$$\therefore \frac{LX}{LZ} = \tan \theta \cdot \cos \gamma \quad \dots \quad (a)$$

$$PL = ZL \cos^2 \gamma \quad \dots \quad (b)$$

$$p = \frac{PZ}{\tan \gamma} = \frac{PX}{\tan \alpha} \quad \dots \quad (c)$$

The triangle XYZ may be drawn from (a).

The point P may be projected from (b).

The circle of projection may be described from (c).

In the Cubic, Tetragonal, and Orthorhombic systems $\theta = 45^\circ$.

Then if $\gamma = 45^\circ$, $\cos \alpha = \frac{1}{2}$.

$$\frac{LX}{LZ} = \frac{1}{\sqrt{2}}, \quad PL = \frac{1}{2} ZL, \quad p = PZ.$$

In the Rhombohedral and Hexagonal system $\theta = 30^\circ$.

Then if $\cos \gamma = \frac{1}{\sqrt{3}}$, $\cos \alpha = \frac{1}{\sqrt{2}}$, $\alpha = 45^\circ$.

$$\frac{LX}{LZ} = \frac{1}{3}, \quad PL = \frac{1}{3}ZL, \quad p = PX.$$

As an example of this mode of projection, Plate IV. gives a figure of all the forms of Pyrargyrite and Proustite which have been recorded, together with a number recently observed by myself. This figure is the intersection of the face-normals by a plane inclined at $54^\circ 44\frac{1}{2}'$ to the vertical axis, and at 45° to two adjacent lateral axes, and at a distance of $b_* = 84.85$ mm. from the origin, where $*$ is the projection of its own normal on the plane of the figure.

The forms marked with an asterisk are new; h' and λ' , which do not appear as separate points on the projection, refer without doubt to the same form. *Vid.* explanation of Plate. (p. 149.)

II.—To draw a perspective figure of any part of a crystal from the projection, it is only necessary to represent the edge between any two faces by a perpendicular to the line joining their projections.

Although it is impossible to project more than a limited number of the faces, the complete crystal may be drawn without difficulty when once the intersections of the planes of symmetry with the plane of the figure have been drawn, by the repetition of the zone-lines in the figure across one or other of these intersections.

The gnomonic projection has the advantages that (like the linear projection) it is a figure actually formed by the crystal and not a representation; the constructions are all made by straight lines; each face is represented by a point; the anharmonic ratio of four faces is the ratio of their intercepts measured along a straight line; and it is by far the easiest graphic method of determining the position of any face. In forming the perspective figures from it no construction lines are required.

[illegible]

Note on some Specimens of Glaucophane-rock from the Ile de Groix.

By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S., F.G.S.

[Read May 10th, 1887.]

IN my description of a Glaucophane-eclogite¹ from the Val d' Aoste, I alluded to the occurrence of a rather similar rock in the Ile de Groix (off the south coast of Brittany) in the following words:—"In the Ile de Groix the glaucophane occurs in no great abundance, with greenish mica, epidote, garnet, hornblende, and but little quartz." My knowledge of the rock, as then stated, was from one or two specimens only; but in the autumn of 1886 I paid a short visit to the Ile de Groix in order to see the rock in the field. I then found that in the above phrase I had unwittingly done an injustice to this locality for glaucophane, for I obtained specimens in which that mineral is even more abundant and almost as well developed as in the rock from the Val d' Aoste. On this account, and as the locality is rarely visited,² I venture to think that a few notes may be interesting to the Society, although the rock has been already excellently discussed by Dr. Charles Barrois,³ to whom I am much indebted for information about this and other interesting localities in Brittany.

The Ile de Groix chiefly consists of mica-schists. These are fairly coarsely crystalline, contain much silvery mica in pretty large flakes, with quartz, and not seldom garnet. Chloritoid is frequently present, the flakes being sometimes nearly .5" in diameter. Hence Dr. Barrois names the group *schistes à chloritoïde*. Occasionally the schist is anthracitic, and at the eastern end of the Island there is a felspathic gneiss. The whole group has evidently been much modified by intense pressure subsequent to the general crystallisation, which has produced what I have termed 'cleavage-foliation' as contrasted with 'stratification foliation.'⁴ In mineral composition and general aspect it has a considerable resemblance

¹ *Min. Mag.* Vol. VII., p. 1.

² It can be reached by a steamer from Lorient. As this starts about 6 a.m. it would be possible to visit some of the localities and get back the same evening to Lorient, but it is better to pass the night in the Island. Near the landing place is an auberge; the entertainment is homely but the people are kindly.

³ *Annales de la Soc. Géol. du Nord.* Vol. XI. p. 18.

⁴ *Presidential Address to the Geol. Soc.* 1886. See *Proceedings*, Vol. XLII.

to the schists which occur towards the middle, as it seems, of the Alpine series.¹

The glaucophane-rock, termed by Dr. Barrois, whose name I will adopt for convenience in this paper, glaucophane-amphibolite,² occurs in the neighbourhood of Locmaria, about the middle of the south side of the Island, and at the eastern end around Fort de la Croix, intercalated in the *schistes à chloritoïde* in masses, generally several yards, occasionally (according to Dr. Barrois) as much as fifty metres thick. I paid particular attention to the relations of the amphibolite to the *schiste à chloritoïde*, a point on which Dr. Barrois hesitates to decide. As my own examination was comparatively cursory, I do not like to speak at all positively, but the evidence appeared to me as in favour of the amphibolite being intrusive in the schist. The one rock did not seem to graduate into the other; the line of parting was not only sharp but also occasionally suggested an intrusive junction. In one place, it is true, I observed that the mica-schist was interbanded with the outer part of the amphibolite, but this might be explained by a crushing out of some fragment of the mica-schist caught up in an intrusive mass of amphibolite.³ The latter rock always exhibits some schistosity, and at the east end of the Island is occasionally distinctly foliated. This structure is parallel with the cleavage foliation in the *schistes à chloritoïde*. About Locmaria its dip is slightly to the east of south, but nearer the eastern end of the Island it becomes about south-west, which appears to be the dominant direction; the angle varies from about 15° to 20° or a little more. The amphibolites, as mapped by Dr. Barrois, appear to cut obliquely across this structure, as we should expect intrusive dykes or sheets to do; moreover the amphibolite of the Ile de Groix (except for the glaucophane and the garnets) resembles in its general structures, mode of weathering, &c. the amphibolites which I saw on the Breton Coast about the embouchure of the Pouldu, and at Roscoff, which I have no doubt are intrusive rocks, modified by subsequent pressures and consequent mineral change.

The glaucophane-amphibolite in the bay south of Locmaria is less schistose than that in the east of the Island, and it bears a remarkable resemblance to the rock from the Val d' Aoste. True, it is in places fairly

¹ *e.g.* Apparently above the rather friable banded gneisses, as on the south side of the St. Gothard group.

² Otherwise I should have retained the name *eclogite*, used in my last paper; for in all the specimens noticed in this garnet is present abundantly.

³ Rather large but ill-preserved crystals of andalusite are developed near the junction of the rocks, chiefly in the mica-schist; possibly this may be indicative of an intrusion.

well banded with epidote and hornblende (as is excellently seen in the pebbles so abundant on the beach), and these bands are occasionally puckered, but in some specimens the foliation is only slight. In the latter case the rock is extremely tough, and, as in the Val d' Aoste, it is difficult to break off good specimens. Macroscopically the resemblance of the two rocks is very close, even to the presence of occasional small flakes of a silvery mica. Microscopically also there is but little difference. There are reddish garnets, epidote, hornblende, glaucophane, as the chief constituents; with quartz, mica, iron-oxide,¹ sphene (?), and rutile as accidentals. The only difference which I observe is that in my slide of this variety of the Ile de Groix rock the garnets have a more definite crystalline outline, there is less green hornblende and more glaucophane; but the crystals of the latter mineral are not quite so large individually and less perfectly defined externally than in the Val d' Aoste rock. But I attach no importance to these differences, because they might not be maintained if a slice were taken from another specimen—the rocks are substantially identical, so far as I can see.

The glaucophane-amphibolites in the eastern part of the Island are generally rather coarser in texture and more definitely foliated than the last named. I brought away four varieties, one of which exhibits a very distinct foliation, the glaucophane and epidote occurring in thin but well-defined bands. The garnets, which are less numerous, are rather larger than usual, being sometimes nearly a quarter of an inch in diameter. Of the other specimens, one differs microscopically from that described above in having a slightly more definite orientation of the minerals. It is very rich in glaucophane. The second, as might be expected from its general appearance, only presents slight differences from the last named, the grains of glaucophane having a less definite orientation. Transverse sections of this mineral are commonly rather less than .02" in diameter, longitudinal about .03", sometimes less, sometimes a little more. The third specimen, however, which is extremely rich in glaucophane, has the crystals of that mineral larger, for sometimes they are almost double of the above dimensions; the garnets also often are about a quarter of an inch in diameter.

Rutile, as identified by Dr. Barrois, is rather abundant in these amphibolites, and is the sole mineral included in the glaucophane. I think that the mineral in the Val d' Aoste rock, which I suggested might be an impure sphene, is very probably a dark coloured, and so perhaps an

¹ Both magnetite and hematite occur variably.

impure rutile. In the Ile de Groix rock the rutile is lighter coloured and more translucent than in that from the Val d' Aoste, but brown grains occasionally occur; also it is more generally disseminated, so as to be almost a normal constituent. The garnet in the former is often rather full of inclusions of a filmy mineral of slightly irregular outline, bright coloured between crossed nicols and with an oblique extinction. These sometimes occur in wavy or bent lines, which may possibly indicate a structure in the rock anterior to the formation of the garnet.¹ As in the Val d' Aoste rock, I think the garnet was formed before the glaucophane. Here also the latter mineral sometimes passes at the exterior into a rather fibrous dark green mineral, whether by subsequent change or the reverse it is difficult to determine, but I incline to his former view. For a very full discussion of the minerals in the Ile de Groix rock I may refer to Dr. Barrois' elaborate memoir.

I have lately received from Prof. B. Kotō, of Japan, a copy of a Paper² describing the discovery of glaucophane in that island. It occurs in a schist, containing, together with "epidote, yellowish green crystals of garnet, quartz, some felspar, rutile, also specular iron" and other constituents, among them "piemontite or manganese epidote." The rock is found in the crystalline-schist system, which is extensively developed, especially in the central mountain chains of the island of Shikoku." He gives an analysis of the glaucophane, and, as his Paper may not be very easily consulted in England, I venture to quote it. The mineral gave, separated by the Thoulet solution:—

SiO ₂	=	56·71
Al ₂ O ₃	=	15·14
Fe ₂ O ₃	=	9·78
FeO	=	4·81
CaO	=	4·80
MgO	=	4·83
Na ₂ O	=	4·88
K ₂ O	=	0·25

 100·15

S.G. 2·9912.

Prof. Kotō also notices the occasional passage of the glaucophane grains at their exterior into a fibrous mineral, which he names crocidolite,

¹ They might be of secondary origin, formed by solution of the garnet along lines of strain; but if this were so, it would be difficult to explain their being bent into S-like folds, as they are in at least two of the garnets.

² *Journal of the College of Science, Imperial Univ.* Vol. I. Part I. (1886).

regarding it as of later origin ; in corroboration of this view, he states that "for microscopic examination a number of specimens had been prepared from different localities, and glaucophane in these slides in the course of some weeks totally lost its original blue colour and turned into a light green substance."¹ He also describes the occurrence of glaucophane in a serpentinous rock. Here the mineral is formed from diallage, as described by myself in the case at Pegli, near Genoa. He regards it as one generally of secondary formation. The occurrence of glaucophane in schists in California has been recently noticed by Dr. Becker (*Amer. Jour. Sci.* Ser. iii. Vol. xxxi. p. 348); but some of the theoretical conclusions in his paper will in my opinion be difficult to substantiate.

¹ I have not noticed any change in my slides; those from the Val d'Aoste are quite eighteen months old.

Notes on the Microscopical Structure of some Eruptive Rocks from Armenia and the Caucasus.

By HJALMAR GYLLING, Helsingfors.

[Read May 10th, 1887.]

IN 1881-1882 Dr. A. Brotherus and his brother, A. H. Brotherus, made a botanical tour in Armenia and the Caucasus; the younger gentleman collected a few specimens of rocks met with during their journey, which, on his return, he kindly left to be examined by me.

This material consisted of later eruptive rocks; it was scanty, but as it was obtained in places from which we have no earlier information of a similar character, I have not thought it uncalled for to make in the following lines a slight contribution to our knowledge of the geognosy of the regions in question.

The microscopical analysis of rocks from the Caucasus made by Tschermak, Lagorio, and Möhl¹ relate in part to the identical rocks that I shall describe, but the localities are different.

The augite-andesites collected by Favre and described by Tschermak² are specimens from Kasbek and its vicinity; those again collected by Abich and described by Lagorio³ are from Kasbek, Ararat, and Kobi. The material at my disposal, consisting of *liparite*, *augite-andesite* and *obsidian*, was mostly found along the general caravan road between Alexandropol in the Caucasus and Charput in Turkish Armenia.

To begin with *liparite*.

Liparite from Kars.—To the naked eye this rock exhibits the following appearance. In a reddish brown cryptocrystalline ground-mass we find porphyritically embedded minute sanidine crystals measuring 1.5-2 mm. in length and 0.5 mm. in breadth. On older fractures the otherwise clear sanidine has by decomposition assumed a yellowish tint. Under the microscope the ground-mass is found to consist throughout of a light-brown microfelsitic substance, in which sanidine, quartz, and a few glass particles are embedded. The sanidine crystals are of vitreous lustre, often

¹ Möhl, *Kaukasische Gesteine*, *Naturwiss. Ges. Isis*. Dresden, 1878.

² Tschermak, *Felsarten aus dem Kaukasus*, *Min. Mitth.* 1872, 2 Heft, p. 107; and *Min. Mitth.* 1875, p. Heft. p. 131.

³ Lagorio A. *Die Andesite des Kaukasus*, *Dorpat* 1880.

coloured yellow-brown by decomposition-products of iron which occur in the numerous fine cracks by which they are traversed. They constitute exclusively simple crystals, extinguishing parallel with the traces PM and LM. Frequently the sanidine crystals are broken and cut off, and the ground-mass is pressed in between the fragments. The sanidine does not contain any interpositions. (Fig. 1.)

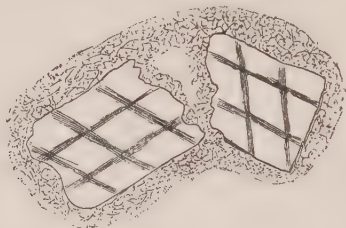


FIG. 1.

The quartz grains embedded in the ground-mass are distinguished by their unusual translucency and by the particularly sharp-defined outlines of their edges. They do not contain interpositions any more than the sanidine.

The glass particles lying scattered in the ground-mass have a dirty-grayish, and are sometimes tarnished of a brown or greenish colour by the action of iron oxide.

As accessory component parts there are apatite and magnetite, the last-mentioned decomposing into red oxide of iron.

Liparite from Charput.—Macroscopically this variety of liparite differs considerably from the preceding one. To the naked eye there appear in the grayish-green microcrystalline or dense ground-mass, porphyritically embedded sanidine crystals, as well as crystals of quartz. These last-mentioned are here, as in the preceding rock, clear and well developed, with exceedingly sharp outlines against the ground-mass.

Under the microscope the ground-mass of the liparite exhibits a well marked microfluxion structure. The sanidine crystals and the quartz individuals are lying in the ground-mass as if immersed in it. Under high microscopic powers the ground-mass presents the aspect of a covering or coat of both lenticular and somewhat lengthened glass particles pressed exceedingly close to one another, between and on which are attached numberless minute globulite-like grains of a greenish colour. Not unfrequently the glass base is developed into spherulitic structures. (Fig. 2.)

The quartz individuals lying in the ground-mass contain included small portions of the glass base of the same, but are otherwise destitute

of any interpositions. This last-mentioned is also the case with the sani-

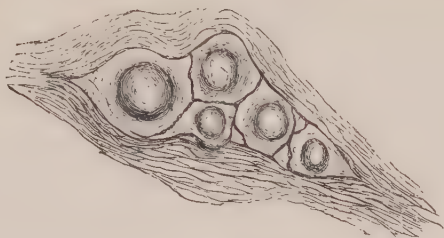


Fig. 2.

ndine, which is traversed by numerous cracks and is, to all appearance, doomed to destruction by way of incipient decomposition.

Augite-andesite from Kars.—The macroscopical aspect of this rock is that of a microcrystalline red-brown cavernous mass, in which to the naked eye are to be discerned minute porphyritically embedded augite crystals. Some of the cavities are filled up with secondary brown-iron ore, calcite and chalcedony. Under the microscope the ground-mass of this rock is found to consist partly of an exceedingly fine-grained crystalline aggregate of minute plagioclase columns and augite, and partly of glass base, to which is added a vast multitude of dark particles. The larger of the plagioclase individuals emerging out of this ground-mass constitute lath-shaped parts, lengthened in the direction of the brachy-diagonal axis, and usually polysynthetically twinned, according to the albite law. Frequently they are besides of a concentric-zonal structure. Several sections of these larger plagioclase individuals were examined as to their optical character, the results thereof being the values of the extinction-angles in the below-mentioned zones.

On measuring the extinction-angles on sections in zone PM (OP : to P ∞) towards the twin-line of the lamellæ on each side of the said line, we obtained the following values :—

$$\frac{35^\circ}{36^\circ} : \frac{34^\circ}{24^\circ} : \frac{32^\circ}{25^\circ} : \frac{29^\circ}{28^\circ} : \frac{33^\circ}{23^\circ} : \frac{30^\circ}{21^\circ} : \frac{35^\circ}{12^\circ 30'}$$

When adding the values on each side of a twin-line thus obtained, we get the following figures :—

$$71^\circ : 58^\circ : 57^\circ : 57^\circ : 56^\circ : 51^\circ : 47^\circ 30'.$$

Compared with the values arrived at by Michel-Levy¹ and Schuster² of

¹ Michel-Levy : *De l'Emploi de Microscope Polarisant*, Ann. des Mines, 1871.

² Schuster : *Optische Orientirung der Feldspathe*, Tschermak's Min. Mitth. Bd. III. 1880.

the angle between the extinction-directions in two plates contiguous to each other, these values seem to point to the existence of a plagioclase with a comparatively high percentage of lime.

In a plate intersected by a basal cleavage, the extinction on $\infty \check{P} \infty$ is -32° towards the trace of $\infty \check{P} \infty$ and $\infty P'$; a circumstance also holding good of Labradorite. Twin-streaked plates, according to the albite and pericline laws, are but very rarely met with.

The augite participates both in the construction of the ground-mass and in forming the porphyritic constituents. It has a pale green-yellow colour, which in the granules contained in the ground-mass assumes a darker tinge. The large porphyritic augite individuals are clear and translucent, having the shape of a short column, which in a cross-section manifests itself in a more or less uniformly hexagonal termination. The prismatic cleavage characteristic of the augite is frequently conspicuously marked.

Augite-andesite from Masgerth.—Macroscopically this rock exhibits a minutely granular brown-red mass, cavernously corroded on long exposed surfaces, in which augite crystals, 1 mm. in size and of bright green colour, are discernible to the naked eye.

When viewed under the microscope, the rock is found to be crystalline throughout. The finely granulated ground-mass is constituted by plagioclase and magnetite, decomposing into red oxide of iron. The porphyritic portions consist of plagioclase and augite. There is no trace of glass-base in the rock. Most of the plagioclase individuals, either merged in the ground-mass or porphyritically embedded in it, have the shape of a lath elongated in the direction of the brachydiagonal axis, and present an ordinary polysynthetic twin-formation, with a comparatively small angle between the extinction-directions on each side of a twin-seam. Several of them have, however, a more marked rectangular form lack a polysynthetic twin-formation, and in their central core or nucleus as well as in their borders appear to be constituted by chemically different plagioclase substance. If the terminations of these probably basal sections are placed parallel with the principal sections of the crossed nicols, it will be found that the extinction-angle of the nucleus of the plagioclase individuals is a different one from that of their borders.

The following figures will demonstrate this :—

Border.	ext.	nucl.	ext.
„	„— 8°	„	„— 15°
„	„— 6°	„	„— 20°
„	„— 7°	„	„— 21°
„	„— 7°	„	„— 18°
„	„— 8°	„	„— 23°

This seems to suggest that the nucleus of these plagioclase individuals consists of some variation of plagioclase with a higher percentage of lime, possibly labradorite, whereas the surrounding matters are made up of a plagioclase with a lower percentage, and are perhaps andesine.

The plagioclase individuals contain included brown glass in great abundance, not unfrequently they are bent and broken into minute fragments.

The augite presents under the microscope the appearance of a wine-yellow colour, and shows scarcely any indication of pleochroism. On the other hand, the augite porphyritically embedded almost always occurs with well-defined terminations. Sometimes the augite is clear and free from any enclosed or attached particles. Sometimes, again, these accumulate in the augite in a vast profusion. Among these inter and juxtapositions, consisting partly of fluid cavities with air-bubbles and partly of magnetite (which evinces a great tendency to pass into red oxide of iron), the former are as a rule included in the central parts of the augite, whereas the latter partly in a narrow zone surround the borders or edges of the augite individuals, and partly group themselves in clusters about a larger or smaller portion of their sections. In the latter case, their profusion may sometimes assume such proportions as almost wholly to cover the augite, leaving it but in a few stray places or points to glimmer forth through the covering of the particles attached.

Obsidian from Kars.—This volcanic product appears in hand specimens black, is perfectly vitreous, and has a shelly fracture. Not the least indication of devitrification is microscopically to be detected.

In a prepared specimen there appears a variety of zone-like bands of almost exclusively pure glass substance; further, such a substance with enclosed minute colourless rod-like crystals ranged in the same direction, belonites; and finally the identical substance with hair-like black straight or geniculated inclusions, besides minute rounded black grains, trichites.

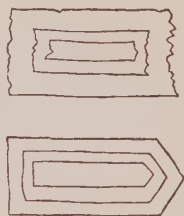


Fig. 3.

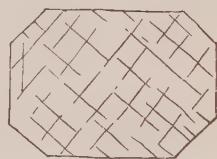


Fig. 4.



Fig. 5.

On a comparison of the Caucasian augite-andesites examined by Tschermak and Lagorio, it will appear that the rocks in question do not, like those from Elbrus and Kasben described by Tschermak, contain quartz, but belong to the group of quartz-free augite-andesites.

As has been done by Lagorio, they may further be divided into a pleocrystalline and a micro-crystalline group, the former of them being represented by the augite-andesite from Masgerth, and the latter by that from Kars.

On Granite containing Andalusite from the Cheesewring, Cornwall.

By J. J. H. TEALL, M.A., F.G.S.

[Read May 10th, 1887.]

THE granite of the Cheesewring Quarry is coarse grained and grey in colour. It is essentially composed of white felspar, quartz and two micas. Tourmaline occurs sparingly. The dominant felspar is orthoclase, frequently twinned on the Carlsbad plan. Crystalline form is not well developed. Under the microscope the individual grains do not, as a rule, give definite extinction. Different portions extinguish at slightly different angles. The arrangement of the different portions is often very irregular; sometimes, however, it gives rise to a striped structure, under crossed nicols, suggestive of micro-perthite; but in no case has a perfectly definite intergrowth of plagioclase and orthoclase been observed. Examined by Szabo's method the orthoclase is seen to be fairly rich in soda. A well striated plagioclase occurs in the rock, but is present in very small quantity. When it does occur it is often seen to be idiomorphic with respect to quartz.

Quartz occurs abundantly in the form of large grains and also as a fine-grained aggregate of irregular individuals. It occasionally shows traces of crystalline outline. The two micas occur in thin plates without any great regularity of form. The dark mica is very strongly dichroic. Sections at right-angles to the basal plane change from a pale brown, when the cleavage cracks lie at right-angles to the short axis of the polariser, to a deep reddish brown (almost black) when the cracks lie parallel to the short axis. This mica is distinctly biaxial, but with a small optic axial angle. It contains inclusions of apatite and zircon. The zircon inclusions are in all cases surrounded by a border in which the colouring matter of the mica has been heaped up as it were. The apatite inclusions, on the other hand, are not surrounded by such a border. It is quite clear that the zircon inclusions have exerted an influence on the distribution of colouring matter in the mica, which the apatite inclusions have not.

The light coloured mica is not, at any rate as a rule, absolutely colourless; at the same time the colour is so slight as to escape notice in thin sections. It is biaxial, with a much larger axial angle than the dark mica. Where zircon inclusions occur in the white mica they are surrounded

by a pleochroic border of about the same width as the corresponding border in the black micas, but not nearly so dense. In the black micas the border is often quite opaque; in the white micas it is faint, but distinct.

Brown tourmaline occurs sparingly and presents no features of special interest. Minute crystals and grains of zircon are fairly abundant. Apatite occurs sparingly. In two or three of the slides examined there occurs another mineral of considerable interest. It possesses a higher refractive power than quartz, but about the same double refractive power. It occurs in more or less elongated crystals which often show a decided approach to crystalline form. Longitudinal sections are more or less lath-shaped, and generally without definite terminations. Cleavage cracks run parallel with the length of the sections. The major axis of the ellipse of elasticity invariably lies parallel with the length of the section. Hence we may infer that the direction in which the crystals are elongated is coincident with the α axis of elasticity—in other words, with the negative bisectrix. The lath-shaped or longitudinal sections often show a marked pleochroism; α red, β and γ colourless in thin sections. This pleochroism is never distributed uniformly throughout any one individual, but is developed in an irregular or patchy manner. Sections more or less at right angles to the direction of elongation show that the crystals are bounded by two pairs of parallel faces. Cleavages parallel with these faces may sometimes be detected, and the extinction-positions bisect the angles formed by the faces.

All the characters above described point to the conclusion that we are here dealing with somewhat ill-developed crystals of andalusite. The faces in the prismatic zone are those of the form $\{110\}$. In one slide a section cut almost at right angles to an optic axis was observed. The form of the section was that of a somewhat imperfect lozenge, the acute angle of which measured 69° . Assuming the mineral to be andalusite, having an optic axial angle of 84° (true), then the acute angle made by the traces of the prism-faces on a plane at right angles to an optic axis would be $74^\circ 2'$. The difference between the observed and calculated results may be accounted for by the fact that the section is not exactly at right angles to the optic axis.¹

The andalusite appears to have as good a claim to be regarded as an original constituent as any other mineral occurring in the rock. It may

¹ The optic axial angle of andalusite varies from 83° to 85° according to Rosenbusch. In Brooke and Miller (New Edition, 1852, p. 285) the half-angle is given as $46^\circ 13'$. If we assume that the above section is exactly at right angles to an optic axis, then it follows that the half angle must be $47^\circ 22'$, a result which agrees very closely with the statement in Brooke and Miller.

be seen in contact with unaltered felspar, and small crystals occur also as inclusions in white mica. In two of the slides examined there are nests exceptionally rich in dark mica and tourmaline. They contain also andalusite, quartz and a colourless mineral occurring in minute acicular prisms. The prisms are aggregated in bundles and sheaves, and occur as inclusions in a mineral having the refractive and double-refractive power of quartz.¹ They give straight extinction, and the γ axis is coincident with the length. They are cross-jointed at irregular intervals, and give chromatic polarisation between crossed nicols. These characters point to sillimanite. It is somewhat curious that two forms of SiO_2 , Al_2O_3 should be present in the same rock. The andalusite gives rise by alteration to aggregates of white mica. This secondary mica, developed at the expense of the andalusite, is readily distinguishable from the normal white mica of the rock. I am indebted to Mr. Butler for the specimens on which the observations contained in this paper are based.

¹ It is possible that cordierite may be present.

Note on Francolite.

By F. H. BUTLER, M.A., A.R.S.M.

[Read May 10th, 1887.]

SOME little confusion having apparently arisen with respect to the characters of certain Cornish apatites, it may be well in the interests of scientific exactitude to point out the following facts.—In a series of specimens of Francolite from Fowey Consols one may observe every gradation of form betwixt long and coarsely striated hexagonal prisms and narrow-edged crystals of an almost lenticular shape. Similar to the latter in their small vertical measurement are the “thin hexagonal plates” which have been enumerated among the known varieties of Cornish apatite, and which are, indeed, indistinguishable in general characters from the recently described Francolite of Levant Mine, St. Just. The particular Francolite, however, which, obtained by Mr. Talling from Fowey Consols, was shown by Maskelyne and Flight to contain over 5 per cent. of calcium carbonate (*Journ. Chem. Soc.* Jan. 1871), must not be identified with any one of the three varieties just mentioned. Carefully distinguishing it, in fact, from the ordinary Fowey Consols form, these authors write as follows:—

“The true francolite consists of small well-defined hexagonal prisms, usually terminated by the basal plane 111. The crystals of the variety under description consist of little aggregated crystals, in which the prisms intersect with each other in a confused manner, which may arise from their being twinned; but with such minute and rough tessellated surfaces it is impossible to determine the twin-plane. The prisms are terminated by a low pyramid, the faces of which form, with those of the prism $2\bar{1}1$, an angle which an average of several measurements by the goniometer, with its object glass used microscopically, gave as $72^{\circ} 47'$.” “The summit plane 111 seems, singularly enough, to be always absent, a not common feature in a true apatite.”

The specimens now exhibited will serve to illustrate the above remarks, and to evidence the still unique character of the Francolite examined by the authors quoted.

Abstracts.

The Crystalline System of Braunite. *Min. u. Petrogr. Mitth.* vii. (1886), p. 443. Dr. Max Schuster concludes from a study of the braunite from Jakobsberg, Wermland, that the crystals from that locality belong to the rhombohedral system, and are tetartohedral and in all probability isomorphous with Hämatite and Ilmenite; the chemical analysis leads to a formula which, expressed in the form $11\text{MnO}_3, 3\text{MnSiO}_3$, is also in accordance with this result.

H. A. M.

Albite from Kasbek.—This mineral, which has proved to be absolutely pure Albite free from all traces of potash and lime, was described by C. Bärwald (*Zeits. f. Kryst.* viii. p. 48), who determined its optical constants. The extinction-angles were found by him to be $+2^\circ 19'$ and $+17^\circ 54'$ upon the faces *P* and *M* respectively, and these values differ considerably from the values predicted for pure Albite by Max Schuster in his classical paper on the optical characters of the plagioclase feldspars.

The latter author (*Ibidem*, p. 373) has re-examined this feldspar, and concludes that Bärwald was misled by the twinning of the mineral, and that the true values are $4^\circ 12'$ and $18^\circ 44'$ respectively, which are practically identical with his calculated values $4^\circ 30'$ and 19° .

H. A. M.

The Crystalline System of Descloizite.—With the help of Bertrand's new microscope Prof. Descloizeaux (*Zeitschr. f. Kryst.* xii. (1886), p. 178) has been able to see the system of rings in a plate normal to the acute negative bisectrix, and to ascertain that they belong without doubt to a rhombic crystal.

H. A. M.

Sur le Granite à Amphibole de Vaugneray (Vaugnerite de Fournet); par Mm. A. Michel-Lévy et A. Lacroix. *Bull. d. l. Soc. Min. d. France*, Vol. X. (1887), p. 27. The rock in question forms a dyke about 400 metres thick in gneiss near Vaugneray, not far from Lyon. It was described by Fournet in 1836, under the name Vaugnerite. The authors show that it is merely a variety of hornblende-granite, and that it has therefore no right to a distinct name. It is dark in colour, and contains numerous scales of black mica. Green hornblende, white feldspar and quartz may also be recognised by macroscopic examination. The elements

of the first period of consolidation are zircon, sphene, hornblende, biotite, labradorite, oligoclase, and orthoclase: those of the second period are orthoclase and quartz. Epidote and white mica are present as alteration products. The zircon is present as very minute quadratic crystals, and where it occurs as inclusions in the biotite and hornblende is surrounded by strongly pleochroic borders. Apatite is extremely abundant. The hornblende is elongated in the direction of the edge 100 : 010, and is frequently twinned parallel to 100. The lamellæ are often as numerous as in the plagioclase feldspars. The pleochroism is feeble in thin sections; α , pale green; β , brown; γ , pale brown. In the pleochroic borders surrounding the zircon crystals rays vibrating parallel to α are emerald-green. The biotite is uniaxial and strongly pleochroic. It appears to be of later date than the hornblende. The labradorite occurs in crystals, and often shows zonal structure. Oligoclase is rare. Orthoclase is abundant, and often shows a kind of hazy twinning suggestive of microcline. It occurs as broken crystals, and also in plates, interfered with by the other constituents. Quartz is abundant, and is interfered with by the other constituents. It sometimes penetrates the feldspar in vermicular infiltrations. Epidote arises in consequence of the alteration of the biotite. The white secondary mica is developed at the expense of the feldspar. J. J. H. T.

Sur le Kerzanton de la Rade de Brest, par CHARLES BARROIS. Ann. d. l. Soc. Géol. du Nord, T. XIV. pp. 31-50.

THE rocks of the Rade de Brest, essentially composed of triclinic feldspar and black mica, and worked under the name of Kerzanton, belong to two principal groups, the one characterised by a granular, the other by a porphyritic structure. The rocks of the former group are termed Kersantites, those of the latter mica-porphyrites (porphyrites micacées), by the author.

Kersantite may be described as a mica-diorite which is often rich in quartz and calcite. Feldspar is the most abundant constituent; it occurs sometimes as whitish or greenish crystals, measuring some millimeters in length, but more frequently in very small grains forming a kind of feldspathic matrix. The feldspar with repeated twinning is oligoclase. It is generally more or less altered. Orthoclase, distinguished by the absence of twinning and by straight extinction in the zone 100 : 001, occurs in certain varieties of the rock.

Next to feldspar a ferro-magnesian mica is the most important constituent. It occurs in prisms, sometimes measuring several millimeters in thickness. The outlines of basal sections may be irregular or hexagonal. In the

latter case they may be regularly hexagonal, or two of the opposite sides may be exceptionally developed. The mica is biaxial with a small optic axial angle. The axial plane is parallel to the two longest sides of the irregular hexagon (010). Sections normal to the base are strongly dichroic; they alternate with lamellæ of white mica and scaly chlorite. M. Barrois regards the white mica as a secondary product. Apatite is very abundant. Iron oxides are comparatively rare.

Quartz is present in variable quantity. Its aspect is that of the quartz of granites. Secondary quartz occurs in veins and geodes. Hornblende is sometimes present, sometimes absent. Augite occurs in many specimens. It is either colourless or a pale green. The prism faces are alone recognisable. It is often represented by a yellowish green alteration product.

The calcite is one of the most interesting constituents of the rock. It has been regarded as original by some writers. It occurs as irregular grains or in the form of pearls; each separate grain or pearl showing individual action under crossed nicols, and possessing the twin structure characteristic of the calcite in marbles. M. Rosenbusch has attributed the calcite to the decomposition of the constituent minerals of the rock. The author calls attention to the fact that calcite occurs in comparatively unaltered specimens. He supposes it to have been introduced into cavities and vesicles by percolating waters; the material having been derived from external sources.

Those varieties of kerzanton to which the author applies the term mica-porphyrite are distinguished from the kersantites above described by a more marked porphyritic structure. The elements of the first consolidation are apatite, black mica, oligoclase and pyroxene; those of the second consolidation are orthoclase, oligoclase, black mica, and iron ores. The secondary products include granular quartz, calcite, chlorite, white mica, hematite and pyrite. The matrix of the rock, composed of minerals belonging to the second period of consolidation, is essentially microlitic. The rocks are much altered. They are identical with the mica-porphyrites of Morvan described by M. Lévy, and with the kersantite-porphyrites of the Erzgebirge described by M. Kalkowsky and M. Rosenbusch. There is no hard and fast line between the kersantites and mica-porphyrites.

The dykes of kerzanton present two types of modification at their margins: (1) amygdaloidal, (2) micro-pegmatitic. The amygdaloidal type is found especially at the margins of thin dykes. The external zone of the amygdaloids is usually formed of chlorite, then follows a zone of chalcédonic or crystalline quartz, and the interior is occupied by calcite. The micro-pegmatitic type is more characteristic of the thicker dykes of kersantite. The matrix is in these cases a typical micro-pegmatite. Included

fragments of quartz, quartz-felsite, micro-granulite, and Devonian slate occur in the kerzantons of certain localities. They may be rounded or irregular in outline, and are generally separated from the rock by a coating of chlorite.

The rocks in question are certainly of later date than the lower carboniferous. Allied rocks occur in the upper carboniferous of Littry in Normandy, and it is probable, therefore, that the kerzantons of Brittany, like those of the Morvan and the Hartz, are of post-carboniferous age.¹

About 50 dykes, varying from 1m. to 20m. in thickness, have been observed in the Rade de Brest.

J. J. H. T.

Sur les Nodules de la Granulite de Ghistorrai près Fonni (Sardaigne), par M. Fouqué. Bull. d. l. Soc. Min. d. France, Tome X. (1887), pp. 57-63.

THE mode of occurrence of these nodules has been described by M. Lovisato, to whom the author is indebted for the specimens which he has examined. They vary in size from that of a hazel-nut to that of one's fist. The rock in which they occur is a coarse-grained granulite, or as we should term it a granite. The constituents of the granite are orthoclase, oligoclase, quartz, biotite, and muscovite. The quartz occurs in large plates, and takes its form from the disposition of the adjacent minerals. The nodules are rounded but of irregular form. They may be readily taken for rounded pebbles. They may be easily detached by the hammer, and they leave a space coated with biotite. The majority of them possess a nucleus similar in every respect to the enclosing rock. Their external portions are formed essentially of albite and biotite. The albite is perfectly fresh. It is twinned according to the albite and pericline-planes. It occurs in plates representing sections of a truncated pyramid. The narrow bases are turned inwards and intimately united with the external surface of the nucleus; the broad bases are turned outwards and form a surface more regular than that of the nucleus. Each plate is formed of a number of individuals, which, however, are often similarly orientated, so that the boundaries of the individuals can only be distinguished by observing the distribution of the twin lamellæ. In the zone giving symmetrical extinctions the maximum double angle is 29° . Chemical tests revealed the presence of soda, and only traces of potash and lime. Hence the felspar is referred to albite or a microcline very rich in soda.

The biotite is arranged in concentric zones. The number of zones is variable, but sometimes reaches as many as eight or ten. The individual

¹ Similar rocks have been described by Mr. Collins from Cornwall (*Journ. Roy. Inst. Cornwall*, Part II, Vol. VIII. p. 30).

lamellæ are irregular, and mostly, though not invariably, arranged in a tangential manner with respect to the nodule. A plate of mica may sometimes be seen to lie in two differently orientated plates of felspar; hence the mica crystallised before the felspar. The biotite of the peripheral portions of the nodule is much fresher than that of the nucleus, or of the rock in which the nodules occur.

The relative size of the central and peripheral portions of the nodules is not constant. The nucleus predominates in the larger nodules. The diameter of the nucleus in such cases may reach two decimeters, the thickness of the albite-biotite border being only one centimeter.

One specimen examined appeared at first sight to be without a nucleus. It was found, however, that the central portions of this nodule consisted of a mixture of the constituents of the ordinary nuclei and those of the external zones.

It appears, therefore, that the nodules consist of two portions:—

- (1) A nucleus formed of a fragment of the surrounding rock; and
- (2) A marginal portion formed by concretion. The surface of contact of these two portions is more irregular than that of the nodule with the surrounding rock.

J. J. H. T.

Beweis für den ursprünglich hyalin-magmatischen Zustand gewisser echten Granite und granitartige Gesteine. K. von CHRUSTSCHOFF. *Neues Jahrbuch*, 1887, Band I. 208-211.

THE author calls attention to the importance of the occurrence of glass-inclusions in the constituents of granite in relation to the theory that granite has originated from the consolidation of an igneous magma.

Zircon invariably belongs to the earliest period of crystalline development, and any inclusions which the zircons of granites may contain will therefore throw light on the condition of the granite-magma before any of the principal minerals of the rock had been formed. The following inclusions have been observed in zircons: (1) colourless belonites, (2) microlites of apatite, (3) smaller crystals of zircon, (4) opaque particles, (5) hollow spaces, (6) fluid inclusions, (7) glass inclusions, (8) needles of rutile.

The occurrence of glass inclusions with two or more bubbles, the forms of the bubbles sometimes showing distortion, have been observed by the author in the granite of Heppenheim in the Odenwald, the quartz-diorite of Weinheim, the Gabbro of Radauthal, the granite of Striegau, a granite-boulder from Markowka (South Russia), and a coarse-grained granite from the neighbourhood of Helsingfors. He remarks on the rarity of liquid inclusions in the zircons as compared with their abundance in the quartz.

The zircons were formed when the proportion of water to the liquid magma was small; the quartz, on the other hand, was formed when, owing to the separation of anhydrous minerals, the proportion of water was large. He regards the glass in the zircon-cavities as representing the original magma by the consolidation of which the granite was formed. J. J. H. T.

Beitrag zur Petrographie des Hererolandes in Sudwest-Afrika. Von HEINRICH WULF. *Min. u. Petrog. Mitth.* Band VIII. (1887), 193-238.

The specimens described in this communication were collected by Dr. Pechuël-Loesche in 1884. They are classified by the author as follows:—

I. ERUPTIVE ROCKS. (1) Granite; (2) Diorite; (3) Basalt.

II. CRYSTALLINE SCHISTS. (1) Gneiss; (2) Mica-schist; (3) Diorite-schist; (4) Amphibolite; (5) Augite-gneiss; (6) Augite-schist; (7) Granular limestone.

III. Sedimentary rocks, minerals, and ores.

IV. Alteration products.

Granite.—This rock is extensively developed in the district, especially between Karibib and Otyimbingue. The dominant variety is a biotite-granite (granitite). Granite with two micas, hornblende-granite, and muscovite granite also occur. Coarse-grained varieties of muscovite-granite are represented in the collection. They are termed pegmatite by the author. The quartz of the granites contains liquid inclusions, and also numerous hair-like bodies. The finest of these appear opaque; the broader ones are colourless, and are referred by the author in part to sillimanite, and in part to apatite. The felspars include orthoclase, microcline, and oligoclase. Titanite is especially abundant in the hornblende-granites. The accessory minerals are magnetite, apatite, and zircon.

The dominant felspar of the pegmatites is microcline. This is often intergrown with albite. The quartz of the pegmatites is intergrown with felspar, as in graphic granite. Tourmaline occurs as a constituent of certain pegmatites.

Diorite occurs south of Karibib. It consists of plagioclase, hornblende, mica, quartz, and titanite.

Basalt. Felspar-basalt occurs in two localities; at Haikamehab and Husab.

Gneiss. The gneisses of the district resemble the granites in mineralogical composition, except that muscovite-gneiss has not been recognised.

Microperthitic intergrowths of orthoclase and microcline with albite or oligoclase-albite were observed. Fibrolite-gneiss is recorded from Sievenberg, sixteen kilometers east of Otyimbingue. Zircon frequently occurs as inclusions in the biotite, and is always surrounded by a border in which the pleochroism is more marked than in the rest of the section. Apatite inclusions in the same mineral are not surrounded by a pleochroic border.

Mica-schist.—This rock is recorded from several localities. A specimen from New Barmen contains macroscopic garnets. Another from a point 5 kilometers west of Pot contains biotite with inclusions of zircon and rutile. A staurolite-bearing mica-schist occurs between Okahandya and Otyosazu. The main mass of the rock is fine grained, but the staurolite crystals are commonly 1 c.m. in length. The pleochroism of the staurolite crystals is very marked; γ = reddish brown, β or γ = yellow.

Diorite-schist.—The author includes under this head certain medium grained hornblende-bearing schists which contain a considerable amount of oligoclase. They contain plagioclase, hornblende, biotite, titanite, quartz and apatite.

Amphibolite.—This rock is distinguished from the diorite-schist by the abundance of quartz, and by the fact that felspar plays a subordinate part in the composition of the rock. It is also of finer grain.

Augite-gneiss.—This is in many respects the most interesting rock described by the author. It is essentially composed of augite, felspar and quartz; scapolite and wollastonite, however, frequently take the place of felspar. A good example of augite-scapolite-gneiss occurs at the copper mine on the Tsoachaub. The scapolite is without crystalline outline. Sections parallel to the direction in which the individuals are elongated show parallel cleavage cracks and give straight extinction. Sections nearly but not quite at right angles to this direction show two sets of cleavage cracks intersecting approximately at right angles, and the extinction position in these sections makes very nearly an angle of 45° with the cleavage cracks. This points to the conclusion that the perfect cleavages are parallel to {110} and not to {100} as is generally stated to be the case. Sections exactly at right-angles to the two cleavage directions remain dark between crossed nicols and give in convergent light the figure of a uniaxial mineral with negative double refraction. The double refraction of the scapolite is stronger than that of either felspar or quartz, and is, of course, most marked in sections parallel to the vertical axis; that is, in sections in which the cleavages are represented by parallel lines. The

scapolite contains no fluid inclusions, but inclusions of hematite (eisen-glimmer) are common. Epidote is occasionally seen in the scapolite, and especially near the junction of scapolite and augite. The iron in the epidote is probably supplied by the latter mineral. The scapolite is attacked by concentrated HCl. The mineral was isolated by the Sonstadt solution and furnished the analysis quoted below.

The augite of this rock shows marked pleochroism, the colours varying from yellowish green to dark green. Its extinction angle in sections parallel to (010) is 47° . Its composition is quoted below. The felspar of this rock is referred to albite by the author. Quartz occurs sparingly. Apatite and muscovite are accessory minerals.

A scapolite-augite-gneiss occurs at Husab. It differs from the rock above described in containing more scapolite than augite and a greater percentage of quartz and felspar. At the same locality occurs a rock rich in microcline and containing augite and titanite. Associated with this rock is another consisting for the most part of garnet and augite—a kind of eklogite. Specimens illustrating the transition from scapolite-bearing augite-gneisses to others in which scapolite is absent occur in the collection. The felspar of these rocks is either labradorite or anorthite.

The wollastonite-augite-gneisses alternate with the scapolite-augite-gneisses to which they are closely related. The wollastonite is elongated in the direction of the ortho-diagonal, or it may occur in a tabular form with conspicuous development of the ortho-pinakoid. More or less lath-shaped sections frequently give straight extinction, in consequence of the fact that the individuals are elongated in the direction of an axis of elasticity. Double refraction strong. Twinning as in ordinary monoclinic pyroxenes (twin plane 100) is very common. Cleavages parallel to (001) and (100). Optic axial plane at right-angles to the direction of elongation. A rock from Reed is composed of wollastonite, scapolite, augite, titanite and garnet. A very remarkable mineral association is represented by a rock from the copper mine. This rock consists essentially of wollastonite and a grass-green diopside. The analyses of both minerals are quoted below.

Augite-schist.—This is represented by a single specimen from the plateau north of the Tsoachaub. It is a fine-grained dark-green rock containing quartz, augite, hornblende, felspar, magnetite with zones of titanite and apatite.

Granular limestone. This rock occurs interbanded with the schists. Five kilometers west of Pot it is associated with mica-schists, and it occurs under similar conditions at a point five kilometers east of Husab.

It is sometimes a pure limestone, at other times it contains accessory constituents, such as olivine, usually serpentinised, mica, and augite. In one case the author observed intergrowths of primary and secondary calcite resembling micro-pegmatite [? Eozoon structure. *Abst.*]

The sedimentary rocks included in the collection comprise a reddish quartzite, a dark grey and a white compact limestone. The minerals comprise specimens of epidote (see below) and specimens of copper ores similar to those described by A. Knop. Under the head of decomposition products the author refers to an arkose cemented by carbonate of lime, and to the sand of Walfisch Bay. The latter consists principally of quartz, but contains also feldspar, augite, magnetite, garnet, zircon, epidote, titanite, rutile, hornblende, and tourmaline.

The petrographical work embodied in this Paper was executed in Prof. Zirkel's laboratory at Leipzig.

	I.	II.	III.	IV.	V.	VI.	VII.
SiO ₂ ...	52·62	53·24	48·23	49·25	51·18	51·62	37·04
Al ₂ O ₃ ...	26·42	25·60	2·73	5·78	1·08	{ 1·35	22·99
Fe ₂ O ₃ ...	tr.	tr.	—				14·19
FeO ...	—	—	18·75	—	—	13·03	—
MnO ...	—	—	tr.	—	—	tr.	tr.
CaO ...	13·11	12·83	22·82	42·48	47·65	24·81	24·09
MgO ...	—	—	6·43	0·93	—	9·54	—
Na ₂ O ...	6·62	7·03	1·40	—	—	—	—
K ₂ O ...	0·45	0·47	—	—	—	—	—
Cl ...	0·10	0·12	—	—	—	—	—
SO ₃ ...	0·79	0·66	—	—	—	—	—
Loss ...	0·45	0·50	—	—	0·42	—	2·16
	100·54	100·45	100·36	98·44	100·33	100·40	100·47
Sp. Gr.	2·683	2·682	3·37	2·81	2·864	3·33	3·40

I. Scapolite from the augite-scapolite-gneiss occurring near the copper mine. The analysis agrees approximately with the formula $Me_1 Ma_1$ according to Tschermak's theory.

II. Scapolite from the scapolite-augite-gneiss of Husab. The analysis corresponds approximately with the formula $Me_9 Ma_{11}$.

III. Augite associated with the scapolite whose composition is represented in I.

IV. Wollastonite of the augite-gneiss from Reed.

V. Wollastonite of the wollastonite-diopside rock from the copper mine.

VI. Diopside from the same rock.

VII. Epidote crystals,

J. J. H. T.

Ueber Chloritoidschiefer von Grossarl. Von A. CATHREIN. *Min. u. Petrog. Mitth.* Band VIII. (1887), 331-337.

THE author describes the petrographical characters of a boulder found near St. Johann, in the Grossarlthal. Macroscopically the rock consists of rounded groups of chloritoid scales about 1 mm. in diameter, lying in a fine-grained yellowish-white groundmass. The lamellæ of chloritoid are grouped in sheaves and bundles. Sometimes they are arranged so as to resemble a double fan. Isolated scales of chloritoid are very rare. Basal sections are rare. They are bluish green in colour and irregular in outline. Lath-shaped sections show a marked pleochroism, the colour changing from yellowish to bluish-green. Under crossed nicols the scales are seen to be composed of two or more thin lamellæ, the basal-plane being the face of composition. This mode of twinning is characteristic of the minerals of the ottrelite group. The lath-shaped sections often show oblique extinction. When the extinction positions of adjacent lamellæ are symmetrical with reference to the trace of the face of composition, the extinction angle referred to this trace is 14° . The groundmass of the rock is composed of quartz, rutile and leucoxene (titanite).

Chloritoid is soluble in dilute sulphuric acid, and the author utilised this property for the purpose of determining the composition of the mineral.

		I.	II.	III.
SiO ₂	...	25.50	92.82	26.17
TiO ₂	...	1.88	6.93	—
Al ₂ O ₃	...	38.69	—	40.38
FeO	...	27.19	—	26.41
CaO	...	0.40	0.76	—
MgO	...	0.08	—	0.08
H ₂ O	...	6.67	—	6.96
		100.41	100.51	100.00

I. Portion soluble in dilute sulphuric acid (67.26 per cent.), containing all the chloritoid and small amounts of titanite, rutile and iron ore.

II. Portion insoluble in dilute sulphuric acid (33.06 per cent.), consisting of quartz, rutile and a small amount of titanite.

III. Composition of the chloritoid as deduced from a consideration of analysis I.

A discussion of the analyses leads the author to the conclusion that the rock consists of 63.98 per cent. of chloritoid, 30.16 per cent. of quartz, 4.03 per cent. of rutile and ores, 1.83 of titanite. It differs from the chloritoid-bearing rocks described by Renard, von Foullon and Schröder in the amount of chloritoid, in the absence of micas, and in the fact that it

does not possess the aspect of a phyllite. It is a true chloritoid-schist, whereas the rocks containing chloritoid which have been previously described are chloritoid-phyllites, chloritoid-mica-schists, and chloritoid-calcite-schists.

J. J. H. T.

The Nature and Origin of Lithophysæ and the Lamination of Acid Lavas.

By J. P. IDDINGS. *Amer. Jour. Science*, Vol. XXXIII. Jan. 1887.

THE rhyolitic obsidian of Obsidian Cliff, in the Yellowstone National Park, is especially remarkable for the extent to which spherulitic structures have been developed. The spherulites possess a radially fibrous and sometimes also a concentric structure. They vary in size from microscopic dimensions to several inches in diameter. In chemical composition they resemble the glass in which they occur. Under the microscope they are seen to be composed of sections of crystalline fibres. The individual fibres do not give straight extinction, and consequently the spherulites do not show a fixed black cross¹ when examined under polarised light. Such spherulites as those described are connected by transitional forms with granophyric [micropegmatitic] intergrowths of quartz and feldspar. Trichites and microlites occur in the spherulites and also in the granophyric aggregates. The fibres of the largest feldspars are composed of microscopic feldspar crystals, and between these fibres are scales of tridymite, grains of magnetite, microlites and gas cavities; thus in the smaller spherulites and in the centre of the large spherulites the silica is present as quartz; in the marginal portions of the larger spherulites it is present as tridymite. Yellow iron-olivine or fayalite, apparently of later origin than the feldspar, occurs in the porous spaces of the larger spherulites. The larger spherulites are frequently hollow. The hollow space may lie near the circumference or may occur in the interior of the spherulites. The fibres project into the hollow spaces. Several cavities arranged in a concentric manner may sometimes be observed. In the laminated lavas the layers of microlites may be followed through the spherulites. The large hollow spherulites are generally hemispherical. They constitute the lithophysæ of von Richthofen. The mineral constituents of the lithophysæ are quartz, tridymite, feldspar, fayalite and magnetite. The feldspar in some cases has the crystal habit of adularia, in others it is tabular. It is described by the author as a soda-orthoclase corresponding to a mixture of one molecule of orthoclase with one of albite, and having an asymmetric character. The fayalite has been previously described in the *American Journal of Science* for July 1885.

¹ They are the pseudo-spherulites of Rosenbusch.

The author summarises the views held by various writers as to the origin of lithophysæ. Some writers regard the lithophysæ as original structures developed in connection with the consolidation of the lava; others regard them as the result of the decomposition of solid spherulites. The lavas of the Yellowstone region are wonderfully fresh, and he considers, therefore, that the latter view is incorrect so far as these are concerned. He holds that considerable light is thrown on the origin of the lithophysæ by the experiment of Daubrée on the effect of super-heated steam on glass, by those of Friedel and Sarasin on the artificial production of orthoclase, albite, quartz and tridymite, and by those of von Chrustschoff on the production of quartz and tridymite. The obsidian of Obsidian Cliff contains 0.66 per cent. of volatile matter, mostly, in all probability, water, and is converted into a kind of pumice by heating in the oxy-hydrogen flame. That the lithophysæ were developed before final consolidation is proved by the fact that when crushed, as sometimes happens, the obsidian may be seen to penetrate for some distance into the cavity. He concludes that the lithophysæ and the minerals associated with them "are of aqueo-igneous origin, and have been produced by the action of the absorbed gases upon the molten glass from which they were liberated during the crystallisation consequent upon cooling." He imagines the formation of a lithophysa to have been somewhat as follows. "In the still plastic glass from a centre of crystallisation a multitude of incipient microlites of felspar radiated through a sphere of glass. As these anhydrous microlites increased in size the nature of the cementing paste was changed. Being impoverished of alumina and alkalis it became more siliceous and relatively more hydrated. A point was reached where the absorbed vapours could no longer be retained in combination, but were released in innumerable bubbles, which were either uniformly disseminated through the paste or aggregated into larger bubbles. The gas thus liberated acted as super-heated steam, and eventually produced the separation and crystallisation of all the elements of the original sphere of plastic glass."

The author next discusses the origin of the laminated structure so characteristic of many acid lavas. This structure is well developed in the lithoidal portion of the obsidian flow which forms Obsidian Cliff. The different layers vary in colour, density and degree of crystallisation. The more crystalline layers are full of minute cavities, and are consequently planes of weakness along which the rock may be split into plates sometimes measuring only $\frac{1}{16}$ th of an inch in thickness. He points out that rhyolitic lavas are more viscous and less uniform in composition at the

time of eruption than basic lavas, and that the laminated structure is the natural result of the deformation of a mass of lava of somewhat variable composition as it takes the form of a flat sheet on a more or less horizontal surface. The views of the author as to the origin of the laminated structures are the same as those long ago arrived at by Mr. Poulett Scrope.¹

J. J. H. T.

Optical Anomalies of Crystals.—The never-failing discussion of the optical anomalies of crystals is continued by R. Brauns (*Neues Jahrb.* 1887 (I.), p. 47), who combats the assertion of Mallard (*Min. Mag.* VII. (1886), p. 46) that sudden cooling does not produce internal strains in a crystal as it does in glass, but causes the former either to crack or to develop twin lamellæ; the author finds, on the contrary, that crystals of rock-salt, sylvine and fluor cautiously heated and then suddenly cooled in oil, become doubly refracting and behave exactly as glass of the same form under the same conditions; and that both rock-salt and glass which have been so treated lose their double refraction when heated, only to acquire it again when cool. Brauns maintains accordingly that internal strains are produced in isotropic crystals by sudden cooling, and that they are the sufficient cause of the optical anomalies.

H. A. M.

Methylene Iodide in Mineralogy.—Brauns (*Neues Jahrb.* II. (1886), p. 72) recommends this liquid both as a specific gravity liquid for separating minerals and also as a highly refracting medium for determining indices by the method of total reflection. Its specific gravity, 3.33, is greater than that of Thoulet's solution, and the variation in the same is very constant, for slight changes of temperature it is reduced to any desired point by dilution with Benzole.

The index of refraction is 1.7487 at 5° (sodium light), the decrease is uniform for equal increments of temperature, and the dispersion diminishes as the temperature increases.

The liquid is not decomposed or diluted by exposure, and is easily purified by shaking it up with diluted potash water.

H. A. M.

Celestine from Lüneburg (*Zeits. f. Kryst.* Vol. XI. p. 220) is the subject of a paper by C. Hintze which has special reference to the study of "vicinal faces." The mineral occurs as granular-crystalline masses in a light-grey marl, and the cavities are lined with small bright crystals shown by analysis

¹ Notice on the Geology of the Ponza Isles. *Trans. Geol. Soc.*, London, 2nd Ser. Vol. II. p. 195.

to be pure strontium sulphate. The dome faces $P \propto \{101\}$ and $\frac{1}{2}P \propto \{012\}$, and the basal plane are accompanied by vicinal faces with very complicated indices, which occur, however, with the same regularity which characterises the vicinal faces of Danburite as established by Max Schuster (see this Magazine, VI. p. 213). In the case of Celestine, Hintze suggests that this regularity may be as well indicated by the direct differences of angle as by the variations of parameters. It is certain that many more observations are required before the nature of vicinal faces can be understood, and that there is great danger of arriving at a hasty conclusion in a matter which is beset with so many difficulties.

H. A. M.

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